# NUCLEAR SCIENCE ABSTRACTS

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April 30, 1975

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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Volume 31, Number 8, April 30, 1975

# NUCLEAR SCIENCE ABSTRACTS

*A semimonthly publication of the USERDA Office of Public Affairs*
*Published by the ERDA Technical Information Center*

*Nuclear Science Abstracts* provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Energy Research and Development Administration and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

The following organizations scan and abstract the nuclear science literature in their respective countries for input to the International Nuclear Information System of the International Atomic Energy Agency. By special agreement, the input to INIS is simultaneously sent to the ERDA Technical Information Center to enhance the timeliness of coverage of that literature in *Nuclear Science Abstracts*.

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Numerous organizations, societies, and publishers throughout the world provide *Nuclear Science Abstracts* with advance page-proof copy of their publications.

A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July 15 issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

**CARTER, G.,** See REED, D.J., 30:21824
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## Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

**REACTOR CONTROL SYSTEMS/PERFORMANCE**
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**REACTOR COOLING SYSTEMS/TRANSIENTS**
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**REACTOR CORES/INSPECTION**
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**REACTOR CORES/STRESS ANALYSIS**
Methods of stress analysis in use at General Atomic for core design (HTGR graphite moderator), 30:23078 (GA-A-12870)

## Corporates

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

23214 (HEDL-TME-74-16) ANALYSIS OF TEMPERATURE PROFILES IN TRANSIENTLY HEATED $UO_2$ USING MOLYBDENUM INCLUSIONS. Wilmot, E. L. **(Hanford Engineering Development Lab., Richland, Wash. (USA)).** [nd]. Contract AT(45-1)-2170. 23p. AT.

is indexed as:

**HANFORD ENGINEERING DEVELOPMENT LAB., RICHLAND, WASH. (USA)**
Analysis of temperature profiles in transiently heated $UO_2$ using molybdenum inclusions, 30:23214 (HEDL-TME-74-16)
HEDL quarterly technical report, January--March 1974. Volume I. Materials technology, 30:21815 (HEDL-TME-74-1(Vol.1))
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Preliminary data report: post-irradiation examination of fuel pins PNL-10-23 and PNL-10-63, 30:23149 (HEDL-TME-74-23)
Prototype applications loop two years of operation, 30:20928 (HEDL-TME-74-24)

## Report Numbers

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Public availability of all U. S. Energy Research and Development Administration reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

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Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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# NUCLEAR SCIENCE ABSTRACTS

## CHEMISTRY

### Analytical and Separations Chemistry

*Refer also to abstracts 19351, 20189, and 20387.*

**19189** (LA-5776) SEALED-REFLUX DISSOLUTION SYSTEM. Dahlby, J. W.; Geoffrion, R. R.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1975. Contract W-7405-eng-36. 8p. Dep. NTIS $4.00.

A simplified pressurized acid system, called the sealed-reflux dissolution system, was designed to dissolve various refractory materials. In this system, the sample and acid solution are heated to 150 to 200°C at 0.3 to 0.8 MPa (50 to 115 psi). Although this temperature and pressure are lower than that attained in sealed-tube methods, the sealed-reflux system has been effective in dissolving high-fired $PuO_2$ and irradiated fuels with as much as 12.5% burnup. (auth)

**19190** (ORNL-5006) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1974. Lyon, W. S. (comp. and ed.). (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 107p. Dep. NTIS $5.45.

Separate abstracts were prepared for each of the six sections. (MCG)

*For abstracts of individual sections see: 19192, and 19201–19205.*

#### Activation and Nuclear Reaction Procedures

*Refer also to abstracts 19608 and 19612.*

**19191** (COO-3015-10) ANALYSIS OF AIR PARTICULATES GENERATED IN THE BOSTON SUMNER TUNNEL AND ENVIRONS. Pszenny, A. A. P.; Russell, I. J. (Boston Coll., Chestnut Hill, Mass. (USA). Dept. of Chemistry). Jun 1974. Contract AT(11-1)-3015. 16p. Dep. NTIS $4.00.

A series of air particulate samples was collected in the 1.1-mile-long Boston Sumner Tunnel on August 31, 1973. Analysis of the samples by neutron activation and atomic absorption yielded data for Au, Br, Ce, Co, Cr, Cu, Eu, Te, Hf, La, Mn, Na, Nd, Pb, Sb, Sc, Th, W, and Zn. Lead and bromine were found to be definitely correlated with automotive activity; Cu, Co, and Mn showed a negative correlation. (LK)

**19192** (ORNL-5006, pp 11-23) NUCLEAR AND PHYSICS METHODS. Lyon, W. S. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

Construction of the x-ray fluorescence analyzer system employing a pyrolytic graphite monochromator is completed, and the instrument is being used for qualitative identifications while calibration and programming for quantitative analysis proceed. The ESCA system (electron spectroscopy for chemical analysis) was used to study surface problems and new applications of ESCA are being developed. Most of the engineering and mechanical problems at the HFIR neutron activation analysis (NAA) lab have finally been resolved, and large numbers of multielement determinations on very small samples have been completed. The PDP-15 computer program MONSTR, developed here, is being used successfully for instrumental quantitative NAA at both HFIR and ORR. Expertise in low-level radioactivity measurement built up over the years through participation in NASA projects is now being applied to problems of local radioactive wastes; the NASA projects continue at a reduced level of effort. Environmental studies being actively pursued include the Allen Steam Plant trace element balance, behavior of heavy elements in soil, water, and vegetation, development of improved methods for assaying radioactive contaminants, and pollution abatement of toxic materials through solvent extraction. A collaboration with the Region II Directorate of Regulatory Operations in assembling, testing, and using a mobile laboratory for on-site verification of uranium inventories is discussed. (MCG)

**19193** (PEL-236) ON-LINE DETERMINATION OF FLUORSPAR IN A CIRCULATING ORE SLURRY BY NUCLEAR TECHNIQUE. de Jesus, A. S. M.; van der Berg, G. W. (Atomic Energy Board, Pelindaba, Pretoria (South Africa). Isotopes and Radiation Div.). Jul 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

A method is described whereby the fluorspar concentration in the tailings in a circulating slurry is rapidly determined by neutron activation analysis using a radioactive source of Am/Be. The 6.13 MeV gamma rays from the decay of $^{16}N(T_{\frac{1}{2}} = 7.1$ sec) produced by the reaction $^{19}F(n,\alpha)^{16}N$, are measured. The solids concentration in the slurry is simultaneously determined by means of a radioisotope density gauge. These two measurements permit the determination of fluorspar directly in the solids fraction. (auth)

**19194** (RLO-2227-T7-27) ATMOSPHERIC TRACE ELEMENT ABUNDANCES AND THEIR APPLICATION IN AIR POLLUTION TRACING. Shum, Y. S.; Loveland, W. D. (Oregon State Univ., Corvallis (USA). Dept. of Chemistry). 1974. 27p. Dep. NTIS $4.50.

The atmospheric trace element abundances associated with examples of several major sources of air pollution in western Oregon, namely, a kraft process paper mill, a plywood manufacturer and a metallurgical processor have been measured using instrumental neutron activation analysis. Air samples were collected directly from industrial stacks and urban areas in Albany, Oregon using high-volume air samplers and tape samplers. The results show enriched concentrations of Zr, Hf, Ta, As, Cl and Br in the metallurgical processor effluent, Na, Cl, Br, Cu, V, Co, Cr and Hg in the kraft process paper mill effluent and Na, K, Cl, Cr, Cu, Br, and Hg in the plywood company effluent. The abundances of the elements Zr, Hf, Ta and As serve as unique tracers for the metallurgical processor stack effluent. Detailed mass balance calculations involving all the trace element abundances allow one to statistically significantly determine the stack effluent dispersal patterns of the three aforementioned concerns. (auth)

**19195** DETECTION OF DEUTERIUM IN WATER BY MEANS OF PULSED PHOTODISINTEGRATION. Ettinger, K. V.; Malik, S. R.; Thomas, B. J. (Univ. of Birmingham, Eng.). Health Phys.; 27: No. 5, 511(Nov 1974).

The determination of deuterium oxide in body fluids can replace tritium in the determination of total body water. A photoneutron method of deuterium assay employing a continuous bremsstrahlung source produced by a linear accelerator was used by Tothill (3rd. Int. Conf. Med. Phys. Göteborg. Paper 20.6 (1972)). Work reported here shows that the pulsing of the accelerator (3-MeV Dynamitron) increases the sensitivity of detection method based on the $BF_3$-filled counters because the pile-up of bremsstrahlung photons can be almost completely eliminated. The results of measurement are not absolute, but the concentration of deuterium oxide can be found by comparison with reference samples of heavy water of known

concentration. The samples used for the measurement need not be purified or pretreated as there are no other elements which can undergo photodisintegration at 3-MeV bremsstrahlung energy, except beryllium which is absent in the body fluids. (UK)

**19196** BONE CALCIUM INDEX BASED ON PARTIAL-BODY CALCIUM MEASUREMENTS BY IN VIVO ACTIVATION ANALYSIS. Harrison, J. E.; Williams, W. C.; Watts, J.; McNeill, K. G. (Univ. of Toronto). J. Nucl. Med.; 16: No. 2, 116-122(Feb 1975).

Measurements of partial-body calcium by in vivo neutron activation analysis have been carried out on normal and osteoporotic subjects. Based on measurements on 16 normal subjects (volunteers less than 55 years of age), a calcium index was established that takes into account variation in skeletal frame size. On the basis of this index, all osteoporotic patients have bone mineral content less than any of the normal subjects. The normal calcium indices ranged from 0.9 to 1.2, and the osteoporotic indices ranged from 0.41 to 0.83. Thirteen of 22 volunteers over 55 years of age had calcium indices less than 0.9 in agreement with the expected loss of calcium with age. Measurements of total-body potassium were also made on these same subjects and the calcium/potassium ratios calculated. Although as groups the older volunteers and older osteoporotic subjects had mean calcium/potassium ratios similar to the mean for the normal subjects, the osteoporotic subjects under 55 years of age had a mean calcium/potassium ratio significantly lower, indicating that for this latter group the loss in bone mineral was not associated with a corresponding loss in muscle mass. (auth)

**19197** APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO FLUORITE IDENTIFICATION IN OPENCAST WORKINGS. Meshcheryakov, R. P.; Panov, Yu. A. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 81-86(1973). (In Russian).

The physical bases of the method of neutron activation analysis used for the determination of fluorite in strip mining were examined. The operational principles and characteristics of the instrument, developed and fabricated by the author, for this analysis were described. The instrument is a $\gamma$ spectrometer and is tuned with a discriminator in the counting of $\gamma$ quanta with energy above 1.33 MeV. The results of field tests with the instrument, confirming the practical possibility of its use for the quantitative determination of fluorite by neutron activation with subsequent registration of the $\gamma$ radiation, were examined. (tr-auth)

**19198** VALIDITY OF THE RADIOECOLOGICAL METHODS FOR NONRADIOACTIVE POLLUTANTS. Bombace, M. A.; Cigna Rossi, L. (CNEN-CSN, Casaccia, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 59-64(1974). (In Italian).

The experience gained in the radioecological field during many years of activity lead to the definition of some criteria which can be used, with minor modifications, to study the behavior of the nonradioactive pollutants in the environment. Therefore it is possible both to establish the diffusion in the environment of some substances and to identify critical groups of the population on the basis of site surveys, food-habits enquiries, collection, and measurements of samples. These criteria were followed in a study on mercury and selenium in an Italian area where such elements were present as natural pollutants. After a preliminary definition of the area the influence of the mine facilities on the environment were studied. Some points with concentrations of the pollutants were also determined and the median daily intake through the food-chain was evaluated. The survey was carried on with specific sampling of biological and abiotic items; socioeconomic and food-habit enquiries were also made. The two chemical elements were measured by neutron activation and mercury by atomic absorption also. (auth)

**19199** MODERN APPLICATIONS OF ACTIVATION ANALYSIS. op de Beeck, J.; Hoste, J. (Ghent Rijksuniversiteit). Analyst; 99: No. 1185, 973-993(Dec 1974).

Applications of neutron-activation analysis have considerably increased in importance since the advent of high-resolution germanium (lithium) detectors. Complex spectra can indeed be analyzed without the need for lengthy chemical separations. An area of application that has been increasingly used is the determination of the inorganic composition of aerosols. By varying the different parameters, such as irradiation time, decay time, thermal or epithermal neutron activation, over forty elements were quantitatively determined, down to the nanogram level. Neutron activation has also been a powerful aid in archaeology, especially in the determination of potsherds. Chemical analysis can provide information about the origin of the pottery, for instance to determine if it is of local or imported origin. Obviously an answer can only be found from the determination of minor and trace elements, as they possibly allow one to distinguish between samples of different origins or to link those with a common origin. Considerable progress was also achieved in activation analysis with 14-MeV neutrons, in which the most important application is still the oxygen determination, either as a major constituent, for instance in rocks, or as a trace element in metals. By taking into account all the parameters that can cause systematic errors absolute standardization procedures were developed leading to a precision and accuracy of approximately 1% relative. Development of relatively inexpensive isotopic neutron sources as californium-252 and actinium-227–beryllium has increased the interest in the determination of major constituents. The advantages offered for a number of elements such as fluorine, manganese, aluminium, silicon and silver are either due to high speed, and/or precision of the analysis compared with other instrumental methods. (auth)

**19200** ANALYSIS OF ARSENIC IN GLASS STANDARDS BY NEUTRON ACTIVATION ANALYSIS. Byrne, A. R.; Ravnik, V. (Jozef Stefan Inst., Ljubljana, Yugoslavia). Radiochem. Radioanal. Lett.; 20: No. 2, 127-136(17 Jan 1975).

The arsenic content of the NBS standard reference glasses was determined by neutron activation analysis at the nominally 0.02, 1, and 50 ppM level. A procedure is described whereby the glass is dissolved in the cold in a closed plastic bottle and arsenic quantitatively extracted as triiodide from the solution into toluene. The method is simple, quantitative and gives results of good reproducibility. (auth)

## Chemical and Spectral Procedures

*Refer also to abstracts 19537, 19810, and 20252.*

**19201** (ORNL-5006, pp 1-10) INSTRUMENTATION AND ADVANCED METHODOLOGY. Ross, H. H. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

The increasing demand for improved analytical technology for environmental analysis has had an effect on the work in both electrochemical and spectrochemical methods. A fundamental evaluation of Hadamard transform spectroscopy for application in the ultraviolet and visible spectral regions was completed. The mathematical model was compared with existing experimental data. State-of-the-art development of new analytical instrumentation was continued. The design, fabrication, testing, and implementation of a new electronic and fusion package for fluorometric uranium analysis was carried out. Other instruments developed recently include a revised voltammeter and a battery-operated potentiostat-galvanostat. Work on computer applications included an effort in the development of pattern recognition techniques for complex analytical data. Other computer applications include a new interface for gas chromatography and an expanded program text for the computer-controlled atomic absorption spectrophotometer. A variety of analytical schemes were investigated and perfected for the determination of organomercury compounds using a combined gas chromatograph–microwave emission spectrometer. The use of this technique is being extended to the assay of arsenic, antimony, and selenium in environmental materials. A new procedure was devised for the analysis of Cr(VI) in natural water by pulse polarography. The analysis is not degraded by the presence of Cr(III), a nontoxic form of the metal. (MCG)

**19202** (ORNL-5006, pp 24-30) ENERGY PROGRAMS: MOLTEN-SALT REACTOR PROGRAM. Meyer, A. S.; Apple, R. F.; Clark, B. R.; Dale, J. M.; Buhl, R. V.; Malone, E. R.; Manning, D. L.; Young, J. P.; Mamantov, G. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

A program plan was prepared to align the analytical effort over the next ten years more closely with other aspects of the MSRP. The long-term objective of the analytical program is to provide the chemical devices and methods for the analyses required to achieve a safe and efficient molten-salt breeder reactor (MSBR). A second important objective is to develop the analytical devices and methods required by the MSRP to conduct meaningful studies and experiments on technology development in diverse areas, including development of materials for the reactor's primary circuit, fuel processing, and the distribution and containment of tritium. In-line measurements are being performed in fuel systems and experimental studies on the electroanalytical chemistry of bismuth and tellurium in fuel salt and of oxygenated and protonated species in fluoroborate melts. Limited support is being provided to other programs through special gas-chromatographic analyses and methods development, in-line gas analyses, and application of computers to analytical methods and data resolution. (MCG)

**19203** (ORNL-5006, pp 31-40) ENERGY PROGRAMS: GAS-COOLED REACTOR PROGRAMS. Costanzo, D. A.; Botts, J. L.; Dyer, F. F.; Farrar, L. G.; LaValle, D. E.; Layton, F. L.; Yeatts, L. B. Jr.; Rogers, W. F. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

During midyear, a Gas-Cooled Reactor (GCR) Analytical Chemistry Development Program was initiated. This program can be loosely grouped into two areas of activity: methods development and technical assistance. The purpose of the methods development and evaluation program is to ensure adequate capabilities for the complete chemical characterization of high-temperature gas-cooled reactor (HTGR) fuel. Due to the uniqueness of the HTGR fuel, it will be necessary either to modify and adapt methods or to develop new ones and then evaluate them to ensure that they are adequate for the accuracy and precision of the fuel specification. Initial efforts are to evaluate these methods for fresh fuel containing $^{235}U$ and then adapt them for glove-box and/or remote operation for analysis of aged recycle fuel containing $^{233}U$ and several hundred ppM $^{232}U$. The presence of gamma-emitting decay products of $^{232}U$ in the aged recycle fuel requires that these analyses be performed in shielded glove boxes or hot cells. (MCG)

**19204** (ORNL-5006, pp 41-53) MASS AND EMISSION SPECTROMETRY. Carter, J. A.; Walker, R. L.; Canada, D. C. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

The addition of an ion microprobe mass analyzer (IMMA) during the past year greatly enhanced the capability of the group, particularly for surface analysis. The IMMA has been used to study the cause of failure of a Pt-Rh-W alloy used as a high-temperature thermocouple, as well as to investigate other alloys where it has been observed that inhomogeneities exist between crystals. A significant improvement in isotopic analysis of plutonium and uranium was the development of Dowex 1 anion resin for the separation of both elements from dissolver solutions. A single resin bead containing both elements can be loaded onto a filament for isotopic analysis by surface ionization, using a tandem mass spectrometer equipped with pulse counting for ion detection. An Associated Electrical Industries MS-50 organic mass spectrometer with high sensitivity and high resolution (100,000) was purchased. Design, development, and expansion of the interactive computer-operated data acquisition and processing system to read photographic plates produced by spark-source mass spectrometers (SSMS) was continued. Mass spectrometric techniques for assessing and measuring environmental quality are being developed. The analytical system for simultaneously measuring total nitrogen and $^{15}N/^{14}N$ ratios was improved by removing from the $N_2$ the $H_2$ formed during the thermal decomposition of $NH_3$. Incorporation of three reaction flasks into the analytical system makes it possible to analyze three samples per hour operating in a sequencing mode. The IDSSMS technique is being extended to 20 or more elements by developing the necessary methodology for multielement isotope dilution. A mass balance for lead, cadmium, and zinc for the Allen Steam Plant was established by IDSSMS. A monopole mass spectrometer was installed in Building 4500S for bio-organic work in the ORNL Tobacco Smoke Research Program. A cooperative effort with the Metals and Ceramics Division in microsphere coating operations led to the purchase of a time-of-flight spectrometer to monitor characteristic by-product components that seem to indicate the quality of microsphere production runs. Service analyses, both mass and elemental impurity spectrometry, are conducted for some 18 ORNL divisions and projects. Over 70,000 analytical results were reported for this period. Isotopic abundance measurements were made on 53 different elements; the isotope dilution techniques developed were put into service laboratories rather quickly, as evidenced by their use for the measurement of samarium, thorium, and uranium in microsphere burnup analyses and for iron in the LWFBR $^{233}UO_2$ preparations. (MCG)

**19205** (ORNL-5006, pp 54-73) BIO-ORGANIC ANALYSIS. Guerin, M. R. Jan 1975.

In Analytical Chemistry Division annual progress report for period ending September 30, 1974.

The principal activity in the Tobacco Smoke Chemistry Project is the chemical analysis of constituents of whole smoke, particulate matter, gas phase, and smoke condensate. Nonfiltered experimental cigarettes of carefully defined composition, approximately 25 types per series, are the principal samples. Cigarettes containing special filters, nontobacco cigarettes, and special-interest products such as a series of German cigarettes are also analyzed. Approximately 10,000 determinations are carried out per year. Approximately 50 constituents, ranging from gases such as CO and NO to compounds such as benzo[a]pyrene and indole, can be determined. The resulting data are compared with bioassay data obtained elsewhere in search of biologically significant constituents. Principal activities in the Inhalation Bioassay Research Project now center around four core tasks: (1) chronic exposure of rats to the inhalation of whole smoke, (2) dosimetry and tolerance studies, (3) tracheal transplant bioassay, and (4) chemistry of the exposure environment. Dosimetry and tolerance studies are designed to test systematically the effects of smoke concentration and standing time, in a search for improved exposure protocols. Tracheal transplant studies are aimed at testing the feasibility of this model to test the carcinogenic potential of whole smokes on respiratory tract epithelium without involving the whole animal. Chamber chemistry studies are aimed at defining the quality of the smoke offered the animals, developing a nondestructive method for measuring dose, and monitoring the performance of machines used in exposure experiments. Compositional changes during exposure are small for organic gas phase and for particulate matter constituents but large for gases (CO, $CO_2$, NO) involved in respiration. The depletion of constituents during the exposure cycle provides a nondestructive measure of total dose and permits determination of the dose of any measurable smoke constituent. The Smoke Exposure System Characterization Project is directed at evaluating exposure systems for reliability and relevance. A basic understanding of the chemistry of contained smoke aerosols is a long-range objective of this work. Work on coal-derived liquids has emphasized the evaluation of existing procedures for possible transfer to coal-derived samples. Phenol, the cresols, titrimetric acids, phenanthrene, benz[a]anthracene, benzo[a]pyrene, indole, and skatole are readily determined in at least one synthetic crude. Multicomponent profiling is readily carried out on coal-derived samples as well. (MCG)

**19206** (RD/B/N-3031) REVIEW OF SODIUM ANALYTICAL TECHNIQUES. Trevillion, E. A. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Sep 1974. 26p. (CFR/CEWP/P-(74)8). Dep. NTIS (US Sales Only) $4.50.

The ability to measure and control impurities in sodium is essential to the success of any liquid metal fast reactor program. Detection and measurement of various impurities can yield important information on processes occurring in a liquid metal environment such as corrosion, mass transfer, fuel element failure, deposition, and gas entrainment. Furthermore, information on impurity levels will give warning of air, water, or oil ingress and is needed to judge the effectiveness of purification systems built into the reactor. Since it is not clear, however, what range of elements is likely to be present in the sodium coolant, sodium analytical programmes should aim at full elemental analysis, which necessitates a range of available analytical techniques. The report discusses the techniques of analysis at present being used in fast reactor programmes and highlights some of the problems associated with the techniques. It considers both on-line activity monitors and techniques based on the classical analysis of sodium samples extracted from the reactor. The equally important operations of sodium sampling, sample separation and sample preconcentration are also discussed. (auth)

**19207** KHIMICHESKIE I FIZIKO-KHIMICHESKIE METODY ANALIZA RUD POROD I MINERALOV. (Chemical and Physico-Chemical Methods of Analysis of Ores, Rocks, and Minerals). Basargin, N. N. (ed.). Moscow; Izdatel'stvo Nauka (1974). 94p.

Twelve sections are included. Three are abstracted and indexed separately for NSA. (JGB)

*For abstracts of individual chapters see: 19208–19210.*

**19208** SPECTROPHOTOMETRIC STUDY OF COMPLEX FORMATION OF Mo WITH THICHROMINE AND POSSIBILITIES OF ITS ANALYTICAL USE. Basargin, N. N.; Nemtseva, Zh. I. pp 47-50 of Khimicheskie i Fiziko-Khimicheskie Metody Analiza Rud Porod i Mineralov. Basargin, N. N. (ed.). Moscow; Izdatel'stvo Nauka (1974). (In Russian).

The complex formed by Mo with thichromine (N-methyl-N,N-bis(methylenechromotropic acid) amine) in HCl at concentrations from 0.01 to 0.1 N had the composition [Mo] : [HR] = 1.1 and was stable for 1.5 to 2 months. The maximum absorption of a solution of the complex was at 640 nm and of the reagent, at $\lambda$ = 370 nm, $\epsilon$ = 10,000, which characterizes the reaction as contrasting and sensitive. The complex formation constant is $6.2 \pm 0.1 \times 10^7$, which indicates a high stability. With this reagent it is possible to determine Mo directly and P indirectly in rocks, ores, and minerals with complex composition. (tr-auth)

**19209** EFFECT OF STRUCTURE OF MONO- AND BIFUNCTIONAL BIS-AZO COMPOUNDS ON THE ANALYTICAL PROPERTIES OF COMPLEX COMPOUNDS WITH La, Ce, Nd, AND Sm. Basargin, N. N.; Volchenkova, V. A. pp 64-74 of Khimicheskie i Fiziko-Khimicheskie Metody Analiza Rud Porod i Mineralov. Basargin, N. N. (ed.). Moscow; Izdatel'stvo Nauka (1974). (In Russian).

The analytical properties [including $\epsilon_{HR}$ (absorption of the reagent), $\epsilon_{MeR}$ (absorption of the rare earth–reagent complex), $pH_{50}$ (pH at mid-point of reaction), composition of complex, number of displaced protons, and $\Delta\lambda$] of La, Ce, Nd, and Sm complexes with mono- (class I) and bifunctional (class II) bis-azo-substituted chromotropic acid were shown to change as a function of the nature of the substituent in the reagent molecule. However, the chemism of the reaction and the nature of the bond between the benzene rings are determining factors and in some cases decrease the effect of the substituent. It was shown that with reagents of class II the bond with the rare earth is an o-carboxy-azo-o-hydroxy group while with class I reagents the bond is a peridioxy group. The rare earth complexes with class II reagents have better analytical properties: $\epsilon_{MeR}$, $\Delta\lambda$, $pH_{50}$. For practical use there is greater interest in bifunctional reagents with the substituents $SO_3H$ and $AsO_3H_3$ ($\epsilon_{MeR} \approx 50{,}000$, $\Delta\lambda \approx 100$–$150$ nm, $pH_{50} = 2.2$–$2.5$). (tr-auth)

**19210** NIOBIUM(V) COMPLEX FORMATION WITH TIPIROGIN. Basargin, N. N.; Panarina, N. A.; Yakovlev, P. Ya. pp 85-89 of Khimicheskie i Fiziko-Khimicheskie Metody Analiza Rud Porod i Mineralov. Basargin, N. N. (ed.). Moscow; Izdatel'stvo Nauka (1974). (In Russian).

The interaction of Nb(V) with tipirogin [N-methyl-N,N-bis (methylenepyrogallol)amine] was studied in 0.25 HCl. Spectrophotometry (displacement of equilibrium and "straight lines" of Asmus) showed that the predominant complexes are those with a ratio of the components of 1:1. The analytically functional group on niobium in the reagent is the hydroxy group of the benzene nucleus in the ortho position. (tr-auth)

**19211** DETERMINATION OF Th–U AND U–Zr ALLOY COMPOSITION WITH A FLUORIDE-SELECTIVE ELECTRODE. Chang, F. C.; Tsai, H. T.; Wu, S. C. (Inst. of Nuclear Energy Research, Lung-Tan, Taiwan). Anal. Chim. Acta; 71: No. 2, 477-481(1974).

**19212** METHODS OF ANALYSIS FOR THE NOBLE GASES. Schmauch, G. E. (Air Products and Chemicals, Inc., Allentown, PA). CRC Crit. Rev. Anal. Chem.; 4: No. 2, 107-139(Oct 1974).

The identification and analysis of noble gases has been a subject of study for over 100 years. This review summarizes the current state of the art and describes the most widely applied techniques and procedures. Considerable attention is given to the determination of impurities in noble gases where, it appears, most of the analytical effort associated with noble gases is applied. The direct determination of noble gases in mixtures and the determination of isotopic abundances are also treated. Gas chromatography and mass spectrometry are by far the most widely applied analytical techniques for the analysis of noble gases. Infrared spectroscopy and emission spectroscopy are also very effectively applied in determinations of impurities in noble gases. Pioneering work is being done in areas associated with low level radioactive noble gases as formed in nature, and with both stable and radioactive fission-product noble gases resulting from nuclear power reactors. With the current emphasis on ecology, environmental protection, and nuclear power, further advances can be anticipated in the direction and identification of trace radioactive noble gas species and in the measurement of their properties. (auth)

**19213** INVESTIGATION OF NORMAL ALKENE ISOMERS IN IRRADIATED PORK AND MEAT FATS BY OPEN TUBULAR GAS CHROMATOGRAPHY. Sojak, L.; Hrivnak, J.; Salkova, Z. (Comenius Univ., Bratislava). Radiochem. Radioanal. Lett.; 20: No. 2, 87-99(17 Jan 1975).

In pork and meat fats irradiated with 0.2–1 Mrad doses n-alkenes with internally situated double bone were identified by gas chromatography. The simple concentrating of volatiles by nitrogen stripping and their freezing-out in the capillary precolumn connected to the separation column, without interruption of the operation conditions of chromatography, provide the high sensitivity of the procedure and render it possible to take advantage of the retention indices for identification. The operation conditions of isolation and analysis were adapted to facilitate the examination of the $C_7$–$C_{19}$ hydrocarbon fraction of the volatile substances. During irradiation of pork and meat fats all possible isomers of straight-chain alkenes are formed. (auth)

**19214** NEW SPOT TESTS FOR THALLIUM(I), BISMUTH(III), AND IODIDE. Johar, G. S. (Vikramajit Singh Sanatan Dharma Coll., Kanpur, India). Mikrochim. Acta; 1: No. 1, 19-23(1975).

New spot tests are described for the selective detection of Tl(I), Bi(III), and $I^-$ ions, with limits of detection 4 $\mu$g, 5 $\mu$g, and 15 $\mu$g respectively, and limits of dilution 1:12,500, 1:10,000, and 1:3300 respectively. Tests are also described for the direct detection of Tl(I) in the presence of Bi(III), and for Bi(III) in the presence of $I^-$. These tests are based on the formation of a red or red-orange precipitate of "thallium bismuth iodide." Most cations and anions, as well as thiourea, hydrazine, and hydrogen peroxide do not interfere. Only Ag(I), Pd(II), Pt(IV), $NO_2^-$, $IO_3^-$, $IO_4^-$, $MnO_4^-$, $S_2O_3^{2-}$ and EDTA interfere. (auth)

## Radiometric and Radiochemical Procedures

*Refer also to abstracts 19588, 19640, 19692, 19731, 19741, 19752, and 20108.*

**19215** (INIS-mf-1604) APPLICATION OF ISOTOPE EXCHANGE IN RADIONUCLIDE SEPARATION: THEORY OF ISOTOPE EXCHANGE. Palagyi, S. (Univerzita P. J. Safarika, Kosice (Czechoslovakia). Katedra Vseobecnej Biologie; Univerzita P. J. Safarika, Kosice (Czechoslovakia). Radiobiologicke Lab.). Jun 1973. 28p. (In Slovak). INIS.

2 parts in one volume, each containing various partial reports.

Radioanalytical application of isotope exchange in heterogeneous solid-liquid and liquid-liquid systems is discussed with a view to theory, particular emphasis being laid on the separation of unstable radionuclides under static and dynamic conditions. Equations are derived for the relation between the isotope exchange separation yield, the amounts of dissolved substances in the respective phases, and the concentration degree referred to ideal conditions. The criteria of the selection of suitable separation models are derived. If a high yield is required together with a high degree of volume concentration, the single-stage exchange procedure under static or dynamic conditions is to be applied; the multistage exchange under static conditions has only limited applicability and is not suitable for the separation from a large number of samples. The single-stage dynamic procedure is rapid, reduces the losses, and results in higher separation yields, a higher separation degree, and a higher volume concentration. (INIS)

**19216** (INIS-mf-1604) MEASUREMENT OF RELATIVE $^{131}I$ GAMMA ACTIVITY OF PEAS IN FRESH MATTER AND IN SOLUTION. Liptakova, G. (Univerzita P. J. Safarika, Kosice (Czechoslovakia). Katedra Vseobecnej Biologie; Univerzita P. J. Safarika, Kosice (Czechoslovakia). Radiobiologicke Lab.). Jun 1973. 19p. (In Slovak). INIS.

2 parts in one volume, each containing various partial reports.

Direct radioactivity measurements of intact plants were compared with measurements of the same weight of fresh plant material in a solution. The feasibility of directly measuring $^{131}I$ gamma radiation from large-volume (100 ml) pea samples (Pisum sativum L. cv. Pyram) was confirmed by the experiment. Both methods are burdened with certain errors; average values, however, did not significantly differ. Direct measurement may be advantageous in monitoring radioiodine uptake by various plant species, in monitoring its cumulation in individual organs, in investigating the time-dependent rate of uptake, and especially in series analyses of plant samples. (INIS)

**19217** (MLM-2205) DEVELOPMENT OF A LOW COST VERSATILE METHOD FOR MEASUREMENT OF HTO AND HT IN AIR. Sheehan, W. E.; Curtis, M. L.; Carter, D. C. (Mound Lab., Miamisburg, Ohio (USA)). 14 Feb 1975. Contract AT (33-1)-gen-53. 15p. Dep. NTIS $4.00.

A low-cost, highly sensitive method for the measurement of HTO and HT in air was developed. The air is first passed through an ethylene glycol bubbler to remove the HTO, then through a heated palladium catalyst where the HT gas is oxidized to HTO and collected in a second ethylene glycol bubbler. The tritium collected by the bubblers is measured by liquid scintillation counting. Recoveries of 95 to 100% with air flow up to 750 $cm^3$/min are routinely obtained. The sensitivity of the method is basically dependent on the liquid scintillation counter background and the counting techniques employed. Several applications of this method of tritium air sampling are in use at Mound Laboratory and are discussed. (auth)

**19218** (RLO-2225-T18-13) RAPID MEASUREMENTS OF TOTAL ALPHA RADIOACTIVITY IN SEDIMENTS OF BIKINI ATOLL LAGOON. Marshall, R. P.; Schell, W. R. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). 3 Jul 1974. Contract AT(45-1)-2225. 25p. Dep. NTIS $4.25.

A rapid technique for measuring total alpha radioactivity in sediments having a constant matrix from sample to sample is presented. Samples are prepared with thicknesses less than the range of the alpha particles in the matrix. Self-absorption corrections for each sample are made using an absorption constant derived from a representative sediment sample. The method was used to compute the $\alpha$-radioactivity in coraline sediments containing different proportions of radionuclides totaling from 3 to 214 pCi/gm. As presented, the method yields relative activity concentrations between samples directly, or absolute concentrations after a correction for activity fractionation between the

whole and prepared sample is made. When put on an absolute basis, concentrations computed using the rapid technique varied by less than 10% from concentrations computed using more conventional self-absorption techniques which require knowledge of the range of alpha particles in the sample matrix. (auth)

**19219** DETERMINATION OF RESIDUES OF NON-IONIC TENSIDES ON COTTON. Schmitz, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Lab. fuer Isotopentechnik); Frotscher, H. Melliand Textilber. Int.; 54: No. 7, 759-761(1973). (In German).

1 fig.; 2 tabs.

The assumption was proved correct that residues of non-ionic tensides are difficult or impossible to remove from cotton fiber. The proof was carried out on cotton tissue strips treated with $^{14}C$-labelled fatty alcohol polyglycol ethers (corresponding running behaviour with the technical non-ionic tenside in a paper chromatogram). Labelling technique and experimental procedure are described. (GE)

**19220** DETERMINATION OF RADIOACTIVE CARBON AND HYDROGEN IN BIOLOGICAL MATERIAL. Frohofer, H. (Zurich Univ. (Switzerland). Organisch-Chemisches Inst.). Z. Anal. Chem.; 271: No. 3, 203-207(Sep 1974). (In German).

6 figs.; 16 refs.

A simple apparatus is described with which any $^{14}C$ and/or $^{3}H$-containing material up to 350 mg can be combusted and accurately counted. Through the use of nitrogen as flushing gas and the elimination of troublesome elements in the combustion tube, only carbon dioxide and water get absorbed. Thus a quick, constant and reproducible count is made possible with a constant quenching effect, even with low-activity products. Inorganic residues are accessible after the combustion and can thus also be analytically determined. Duration of analysis: 12 min. Precision: ±2.5%. Counting yield of $^{14}C$arbon: 83%, for tritium: 36%. (auth)

**19221** APPLICATION OF THIN-LAYER GEL FILTRATION IN THE MICROANALYSIS OF RADIOIODINATED PROTEINS. Hruska, K. J.; Franek, M. (Veterinary Research Inst., Brno). J. Chromatogr.; 93: No. 2, 475-479(1974).

**19222** RECENT DEVELOPMENTS IN X-RAY SPECTROMETRY. Macdonald, G. L. (Mullard Mitcham, Surry, Eng.). CRC Crit. Rev. Anal. Chem.; 4: No. 3, 281-322(Jan 1975).

The discussion includes sections on dispersion and detection, excitation, x-ray spectrometric equipment (x-ray fluorescence spectrometers and electron-beam instruments), quantitative x-ray spectrometry, sample preparation, trace analysis, light element analysis, and applications and future development. (339 references) (JGB)

**19223** RADIOMETRIC ESTIMATION OF THE AMOUNT OF SOLID GASTROINTESTINAL CONTENTS. Pfau, A.; Abadir, F. A. (Institut fuer Tierzucht und Tierverhalten FAL, Mariensee, Ger.). Experientia; 30: No. 11, 1296-1298(15 Nov 1974).

A dilution technique using radioactive labels is described for estimating the volume of the gastrointestinal contents of large ruminants. Europium-152 was used as a label of the solid phase. The liquid phase was labeled with $^{14}C$-polyethylene glycol. Twelve 78-week-old bulls were used. Fecal excretion measurements were made to determine turnover rate of the ruminal solid phase. Fecal turnover rate constants and ruminal dry matter intake rate constants were determined. (HLW)

**19224** EQUIPMENT FOR RADIATION ANALYSIS. Habanec, J. Czech Patent 149061. 23 Aug 1972. 4p. (In Czech).

Equipment is described for the analysis of chemical substances with low resistance to thermal effects. The equipment consists of a particle accelerator, a magnetic monochromator, a collimator, and a measuring chamber in which is located a target equipped with a cooling device, revolving around the axis, or reversibly sliding in the direction of the axis or normal to the axis. The measuring chamber is equipped with a spectrum detector, possibly also with a detector for checking the energy and intensity of particles. The cooling equipment is adjusted for the use of a liquid coolant, for instance for the use of liquid nitrogen. (INIS)

**19225** RADIOANALYTICAL METHODS BASED ON ISOTOPIC EXCHANGE. Kratzer, K.; Stary, J.; Zeman, A. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 11-16 (1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

Homogeneous isotopic exchange between diethyl dithiocarbamate and iodide complexes of metals in an organic solvent was applied in selective determination of bismuth (0.01 to 1.5 μg), arsenic (0.1 to 10 μg), and antimony (0.5 to 20 μg). Homogeneous isotopic exchange in the organic phase between chelates of various valencies of the metal determined was used in the determination of trace amounts of thallium (0.02 to 10 μg) and cerium (0.1 to 10 μg). Diethyl dithiocarbamidic acid was used as the chelating agent in the former case, di-(2-ethylhexyl)-phosphoric acid was used in the latter two cases. Another radiochemical method making possible a highly selective determination of lead traces (0.01 to 0.5 μg) is based on two-phase isotopic exchange between an aqueous solution of the tartrate complex of lead and a standard solution of diethyl dithiocarbamate in carbon tetrachloride. (auth)

**19226** RAPID COLUMN-CHROMATOGRAPHIC DETERMINATION OF FREE $^{99m}Tc$ IN LABELED RADIOPHARMACEUTICALS. Colombetti, L. G.; Pinsky, S.; Moerlien, S. (Loyola Univ., Chicago). Radiochem. Radioanal. Lett.; 20: No. 2, 77-85(17 Jan 1975).

Use of the chromatographic system described in this paper makes possible rapid and reliable determination of the percentage of free pertechnetate in radiopharmaceuticals. The procedure takes only three to five minutes to perform, as compared with the 30 to 40 minutes needed for instant thin layer chromatography. It has proved to be accurate and dependable in a clinical setting. (auth)

**19227** ESTIMATING THE ERRORS OF THE GAMMA-ABSORPTIOMETRIC METHOD OF DETERMINING THE ASH OF COAL. Lokshin, A. G. Coke Chem., USSR (Engl. Transl.); No. 4, 13-15(1973).

The gamma-absorptiometric test for ash as a quality-control procedure on the charge eliminates from the testing process the operations laid down by GOST 9080-59 and 11022-64, and thereby reduces the total error of the procedure. The r.m.s. difference between ash values determined by the gamma-absorptiometric and standard procedures is ±0.355 per cent absolute and arises in equal measure from the errors incurred by the two procedures. The standard error of the gamma-absorptiometric procedure for determining the ash of the charge is ±0.24 per cent absolute, while the combined standard error of the operations it supersedes is ±0.26 per cent absolute (for absolute values of the ash of the charge in the range investigated, 6.2 to 9.0 per cent). (auth)

**19228** HANDLING OF RESULTS FROM RADIOACTIVITY MEASUREMENTS. II. Korobkov, V. I.; Luk'yanov, V. B. pp 117-204 of Metody Prigotovleniya Preparatov i Obrabotka Rezul'tatov Izmereniy Radio-Aktivnosti. Moscow; Atomizdat (1973). (In Russian).

Statistical methods for handling radioactivity measurements are discussed. The material is presented in such a way as to give readers unfamiliar with statistical methods an opportunity of mastering the basic principles of their use for handling experimental results. The literature references include only recent monographs and textbooks. The experiments mentioned indicate the directions and methods of modern mathematical statistics. (tr-auth)

**19229** METHODS OF SAMPLE PREPARATION FOR RADIOACTIVITY MEASUREMENT. I. Korobkov, V. I.; Luk'yanov, V. P. pp 5-116 of Metody Prigotovleniya Preparatov i Obrabotka Rezul'tatov Izmereniy Radio-Aktivnosti. Moscow; Atomizdat (1973). (In Russian).

An attempt was made to generalize the results of experiments on preparing samples for making radioactivity measurements and to systematize the most important of these for use when relative and absolute measurements are to be made. Some attention is given to preparation of radiation sources. Thin substrates are considered, especially thin organic films. Analysis of a very large number of experiments indicates that the great majority of research workers have used a total of four or five methods for sample preparation. Therefore only the most widely used methods are described in detail. References are given only to the original work in which the detailed methods are described. (tr-INIS)

**19230** SUB- AND SUPER-EQUIVALENCE METHOD OF ISOTOPE DILUTION ANALYSIS. II. Determination of Traces of Cobalt. Toelgyessy, J.; Lesny, J.; Klas, J. (Slovak Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 20: No. 2, 159-162(17 Jan 1975).

Trace amount of cobalt (1.09 μg/ml) was determined by sub- and super-equivalence isotope dilution analysis. EDTA was used as a reagent. The resulting negatively charged cobalt(II) complexonate was separated from the unreacted cobalt on cation exchanger Dowex-50. (auth)

## Separation Procedures

*Refer also to abstract 19582.*

**19231** (CEA-CONF-2704) BEHAVIOR OF ION EXCHANGE RESINS WITH RESPECT TO CHLORIDES. Effect of the Conditioning with Boric Acid and Lithium Oxide. Rozenberg, J.; Dolle, L.; Paoli, O. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Analyses et d'Etudes en Chimie Nucleaire et Isotopique). [nd]. 6p. (In French). (CONF-740468-3). Dep. NTIS (US Sales Only) $4.00.

From reactor conference; Berlin, F.R. Germany (2 Apr 1974).

The effect of boric acid and lithium oxide in the water of the primary circuit of a reactor on the capacity of a strongly anion exchange resin to retain $Cl^-$ was studied. The results showed that the resin can fix only a very low quantity of the chlorine if either of these two contaminants is present. (JSR)

**19232** (EGU-05130704) RADIOACTIVE BEHAVIOUR AND REMOVAL IN NUCLEAR POWER STATIONS. II. Pietrik, I. (Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). 1973. 74p. (In Czech). INIS.

37 figs.; available from Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia). Knihovna.

Results are reported of the study into rare gas sorption on and radioiodine desorption from impregnated alumina, and into the effect of aging of this material on radioiodine sorption. The removal of radioiodine and methyl iodide by $AgNO_3$-impregnated kieselguhr was also studied. Equations were derived describing radioiodine and methyl iodide removal by inorganic sorbents; the validity of the equations was proved experimentally. Also studied was the radiation and pyrolytic formation of $CH_3I$ and HI. The dependence of $CH_3I$ and HI yields on dose rate and temperature was determinated experimentally. (auth)

**19233** (JAERI-M-5785) CATION-EXCHANGE SEPARATION OF THE TRANSPLUTONIUM AND RARE-EARTH ELEMENTS. Umezawa, H.; Ichikawa, S. I.; Natsume, H. (Japan Atomic Energy Research Inst., Tokyo). Jul 1974. 11p. (In Japanese). Dep. NTIS (US Sales Only).

Various gel- and porous-type resins were tested for use in the cation-exchange chromatography with an eluent of 11.7 M hydrochloric acid. When gel-type resins were used, very fine resins, such as colloidal aggregate, were needed to perform good separation. The lower cross-linkage resins provide the larger number of theoretical plates of the column, but the distribution coefficients and separation factor become smaller. While those coefficients obtained with the porous-type resin were similar to those obtained with the gel type of the same cross-linkage, the number of theoretical plates for the porous type increased by a factor of about 3 and tailing in the elution curve decreased remarkably. Three groups of Am-Cm, Y, and Eu-Ce can be well separated by using a 4 mm diam. by 20 cm height column of a porous-type resin, DIAION CPK08, 35 $\mu$, with 11.7 M hydrochloric acid. (auth)

**19234** (RLO-2225-T11-5) SEPARATION EFFICIENCY OF PULSED EXTRACTION COLUMNS. Dynamics of Solvent Extraction Systems. Liquid and Gas Phase Separations. Final Report. Babb, A. L.; Garlid, K. L. (Washington Univ., Seattle (USA). Dept. of Nuclear Engineering). Jul 1974. Contract AT(45-1)-2225. 20p. Dep. NTIS $4.00.

Research on the separation efficiencies of pulsed extraction columns for the contract period Jan. 1, 1957 to Dec. 31, 1967 is summarized. The following studies are evaluated individually: design correlations for pulsed-sieve plate extraction columns, for longitudinal mixing effects in the continuous phase, for mass transfer, for holdup of dispersed phases, and for longitudinal mixing in dispersed phases. Research during the following four years on the dynamics of solvent extraction systems included studies on holdup and fixed distribution of holdup, as well as transient holdup behavior of pulsed columns, controlled cycling operation of a pulsed column, mathematical model for controlled cycling operation of a pulsed column, and application of power spectral density analysis to anticipate pulsed column flooding or other anomalous behavior. For the final year of the contract period, studies centered on the separation of $^{85}Kr$ and N gas mixtures using thin, semi-permeable, silicone membranes. (JGB)

**19235** EXTRACTION OF THE HYDROXYNITRATES OF ZIRCONIUM AND HAFNIUM BY CYCLOHEXANONE. Klyuchnikov, V. M.; Solov'eva, E. S.; Korovin, S. S. Zh. Neorg. Khim.; 19: No. 11, 3082-3087(Nov 1974). (In Russian).

A study was carried out on the extraction of zirconium and hafnium by cyclohexanone from nitric acid and nitrate solutions which are acid deficient. It was established that the extraction of these elements can take place both in the form of neutral nitrates and also of hydrolyzed nitrates. The extraction of the hydroxynitrates of Zr and Hf is brought about by complexing with the cyclohexanone entering the coordination spheres of the elements to be extracted. (SJR)

**19236** RARE EARTH AND THORIUM COMPLEXING WITH A NUMBER OF PHOSPHO-ORGANIC ACIDS IN AQUEOUS SOLUTIONS. Guseva, N. N.; Mikhailichenko, A. I.; Karapet'yants, M. Kh.; Sklenskaya, E. V. (Moscow Chemical-Tech. Inst.). Zh. Neorg. Khim.; 19: No. 11, 2994-2997(Nov 1974). (In Russian).

By a kinetic method at 25°C and an ionic strength of ~0.02 a determination was made of the stability constants of rare earth complexes having a composition $LnA^{2+}$ and thorium complexes having a composition $ThOHA^{2+}$ with eight dialkyl (diaryl) phosphoric acid and dialkyl (aryl) phosphinic acids in aqueous solutions. A study was made of the effect of the nature of the radical-substituent in the phospho-organic acid on the value of the stability constant of the complexes, the change in stability constant in the rare earth series, and the dependence of the change on the nature of the acid. (SJR)

**19237** SEARCH FOR SUPERHEAVY ELEMENTS IN NATURE. I. Possibilities for Concentrating Element 114. Medeiros, J. A.; Miekeley, N. (Pontificia Univ., Catolica, Rio de Janeiro). J. Inorg. Nucl. Chem.; 36: No. 12, 3659-3665(Dec 1974). (In German).

Starting with some extrapolated properties of eka-lead, methods for an enrichment of possible residual traces of this element are discussed. In detail are proposed: volatilization, coprecipitation of $114^{2+}$ with $PbSO_4$ and counter-current electrophoresis. Experiments are reported for estimating distribution coefficients in the system $114^{2+}_{micro} - PbSO_4$, as well as differences in migration velocities between the aceto complexes of eka-lead and its lower homologue. (auth)

**19238** METHOD OF SEPARATING CESIUM FROM AQUEOUS SOLUTIONS. Rais, J.; Selucky, P. Czech Patent 149404. 29 Sep 1972. 2p. (In Czech).

A method is described for extracting cesium from aqueous solutions in the presence of the tetraphenylborate of an alkali metal to an organic solvent immiscible with water, in the presence of a 2,3,11,12-dibenzo-1,4,7,10,13,16-hexaoxocyclo-octadeco-2,11-diene solution. Cesium is thus converted to a complex salt of cesium tetraphenylborate with the said diene. The shaking of the liquid results in the extraction to the organic solvent. (INIS)

**19239** METHOD OF SEPARATING RADIORUTHENIUM. Krtil, J.; Menci, J. Czech Patent 149050. 23 Aug 1972. 2p. (In Czech).

Separation of radioruthenium from a mixture of uranium fission products is described. An alkali persulfate and an alkali carbonate are added to the aqueous solution of the uranium fission products. The mixture is heated and distilled at reduced pressure of the water column while bubbled with air. Ruthenium dioxide is collected in an inorganic acid containing some hydrogen peroxide. The method yields up to 99 wt % ruthenium tetroxide. (INIS)

**19240** METHOD OF CESIUM SEPARATION. Rais, J.; Selucky, P. Czech Patent 149403. 29 Sep 1972. 2p. (In Czech).

A procedure is described of separation of cesium from aqueous solutions in the presence of the dipicrylaminate of an alkali metal. The aqueous solution of the dipicrylaminate of an alkali metal and the solution of 2,3,11,12-dibenzo-1,4,7,10,13,16-hexaoxocyclo-octadeca-2,11-diene in an organic solvent immiscible with water are added to the aqueous solution of cesium. Cesium is thus transformed into the complex salt of cesium dipicrylaminate with the above diene. Shaking of the liquid obtained will result in the extraction of cesium into the organic solvent. (INIS)

**19241** SEPARATION AND CONCENTRATION OF RADIOIODINE BY ISOTOPE EXCHANGE IN A HETEROGENEOUS LIQUID SYSTEM UNDER STATIC CONDITIONS. I. Separation Efficiency and Degree of Volume Concentration. Palagyi, S. (P. J. Safarika Univ., Kosice, Czech.). Radiochem. Radioanal. Lett.; 20: No. 2, 101-109(17 Jan 1975).

The mutual relation between separation efficiency and degree of volume concentration of radioiodine by one-stage isotope exchange in a heterogeneous system formed by $^{131}I^-$ in water and $I_2$ in organic solvent at various ratios of concentration of $I_2$ to $I^-$ was studied. Under certain conditions, the calculated values of separation efficiency were found to be in good agreement with the values determined experimentally. (auth)

**19242** SEPARATION AND CONCENTRATION OF RADIOIODINE BY ISOTOPE EXCHANGE IN A HETEROGENEOUS LIQUID

SYSTEM UNDER STATIC CONDITIONS. II. Rapid Separation of $^{131}I$ From Various Water and Biological Samples. Palagyi, S.; Zaduban, M. (P. J. Safarika Univ., Kosice, Czech.). Radiochem. Radioanal. Lett.; 20: No. 2, 111-120(17 Jan 1975).

A simple method for the rapid separation of radioiodine based on the one-stage isotope exchange between $I^-$ and $I_2$ in a heterogeneous liquid system under static conditions is described. The method is suitable for the rapid separation of radioiodine from various samples of both inorganic and biological origin also in the presence of some of the most important fission products. (auth)

**19243** ELIMINATION OF ZIRCONIUM AND NIOBIUM FROM URANIUM SOLUTION. Maroto, A. J. G.; Peluffo, C. A.; Dupetit, G. A.; Kaufmann, F.; Flegenheimer, J. G. (Comision Nacional de Energia Atomica, Buenos Aires). Radiochem. Radioanal. Lett.; 20: No. 2, 121-126(17 Jan 1975).

A method for adsorbing fission products from uranium solutions was studied on the laboratory scale. More than 90% of the $^{95}Zr-^{95}Nb$ pair can be retained on colloidal silica from liquids simulating the dissolver solution of reprocessing plants. (auth)

**19244** CHANGE OF ION EXCHANGE BEHAVIOR OF ZIRCONIUM PHOSPHATE DUE TO TREATMENT WITH ALCOHOL AND ETHER. Marei, S. A. (Univ. of Libya, Tripoli); Shakshooki, S. K.; Aly, H. F. Radiochem. Radioanal. Lett.; 20: No. 2, 137-142(17 Jan 1975).

It was found that washing the zirconium phosphate ion exchanger with alcohol or ether before drying changed its exchanger behavior. For $Na^+$ ion uptake by zirconium phosphate the distribution coefficient increases in the case of washing the exchanger with alcohol or ether. For $Eu^{++}$ ion the distribution coefficient increases in the case of alcohol washing but it decreases if the sample is washed with ether. An attempt to explain this behavior will be given. (auth)

**19245** ANTAGONISTIC AND SYNERGISTIC COMBINATIONS OF TTA AND NEUTRAL ORGANIC SOLVENTS IN THE EXTRACTION OF TERBIUM FROM A MOLTEN EUTECTIC. Lengyel, T. (Inst. of Isotopes, Budapest). Radiochem. Radioanal. Lett.; 20: No. 2, 143-150(17 Jan 1975).

The distribution of terbium between molten lithium nitrate–ammonium nitrate eutectic and combinations of TTA with neutral organic solvents has been investigated. Synergistic and antagonistic effects up to four orders of magnitude have been found due to the formation of mixed complexes. (auth)

**19246** EXTRACTION TECHNOLOGY FOR THE RECOVERY OF INDIUM FROM ZINC PRODUCTION SOLUTIONS. Mal'tsev, V. I.; Startsev, V. N.; Getskin, L. S. Tsvetn. Metal.; No. 11, 18-20(Nov 1974). (In Russian).

The characteristics of the solvent extraction technology for the recovery of In from sulfate solutions of zinc production are discussed. It is shown that uniformly organized extraction technology for the preparation of In with rigid maintenance of the technological regime of the operation of electrolytic purification of the raffinate makes it possible to eliminate the harmful effects of both organic and inorganic impurities on the Zn production. (tr-auth)

# Inorganic, Organic, and Physical Chemistry

**19247** STUDY INTO ISOTOPE EFFECT IN HYDROGENATION OF MALEIC ACID IN LIQUID PHASE ON Ni–ZnO TYPE CATALYSTS. Kudlacek, R. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 41-46(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

In the hydrogenation of maleic acid on Ni-ZnO catalysts, standard conditions were found for the catalyst stability, the composition and the stability of the solution and the reacting gas, and for the accomplishment of the reaction. The reaction was studied as related to the solution pH before and after sorption of the acid on the catalyst. Experimental results yielded knowledge on the optimal set-up of the microhydrogenation device, the preparation of the catalyst, the composition of the solution, the sorption processes of reacting components, and on the isotope effect values. (INIS)

## *Chemical and Physicochemical Properties*

*Refer also to abstracts 19352, 19353, 20187, 20234, 20409, 20410, and 20496.*

**19248** (ANL-8123) CHEMICAL ENGINEERING DIVISION, PHYSICAL INORGANIC CHEMISTRY ANNUAL REPORT, JULY 1973–JUNE 1974. Blander, M.; Cunningham, P. T.; Feder, H. M. (Argonne National Lab., Ill. (USA)). Nov 1974. Contract W-31-109-eng-38. 56p. Dep. NTIS $5.45.

Separate abstracts were prepared for the 12 individual studies made. (JSR)

*For abstracts of individual sections see: 19249–19260.*

**19249** (ANL-8123, pp 5-6) LITHIUM–LITHIUM DEUTERIDE SYSTEM. Veleckis, E. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

Tensimetric measurements of the equilibria between $D_2$ and molten Li-LiD solutions have been made at temperatures ranging from 705 to 871°C. The miscibility gap deduced from the measurements ranges from 0.238 to 0.979 mol % LiD at 705°C and from 0.415 to 0.908 mol % LiD at 871°C. These limits are very close to those for the Li-LiH system. For a given composition and temperature, the pressures of $D_2$ over Li-LiD solutions are higher than $H_2$ pressures over corresponding Li-LiH solutions. (auth)

**19250** (ANL-8123, pp 6-9) STUDIES OF THE SOLUBILITY OF $Li_3N$ IN LIQUID LITHIUM. Veleckis, E.; Yonco, R. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

A filtration technique was utilized to measure the solubilities of solid $Li_3N$ in liquid lithium at temperatures ranging from 195 to 441°C. A least squares analysis of 22 measured solubilities leads to the expression $\log_{10} S = 3.323 - 2107\ T^{-1}$, where S is in mol % $Li_3N$ and T is the Kelvin temperature. (auth)

**19251** (ANL-8123, pp 10-12) STUDIES OF TRITIUM DISTRIBUTIONS IN LITHIUM-CONTAINING SYSTEMS. Wolson, R. D.; Staahl, G. E.; Maroni, V. A. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

The distribution of tritium between liquid lithium and the three molten salt eutectics LiF-LiCl, LiCl-KCl, and LiBr-RbBr was measured. The molar distribution coefficients (moles T per mole of salt/moles T per mole of lithium metal) are 6.6 ± 2.0 in the LiF-LiCl eutectic at 600°C, 5.5 ± 1.0 in the LiCl-KCl eutectic at 550°C and 3.5 in the LiBr-RbBr eutectic at 500°C. The results indicate that the tritium bred in a liquid-lithium fusion-reactor blanket can be extracted and recovered using molten salts. (auth)

**19252** (ANL-8123, pp 13-15) MEASUREMENT OF THE LIMITS OF SUPERHEAT OF LIQUIDS. Renner, T. A.; Kucera, G. H. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

Measurements were made of the limits of superheat of the two mixtures n-propane–n-butane and n-pentane–n-octane. The limits were linear in mole fraction. If generally true, such linearity greatly simplifies the analysis of contact vapor explosions of hydrocarbon mixtures in terms of a nucleation mechanism. (auth)

**19253** (ANL-8123, pp 15-18) LIMIT OF SUPERHEAT OF LOW-MOLECULAR-WEIGHT HYDROCARBONS AND THEIR MIXTURES. Porteous, W.; Blander, M. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

The limits of superheat of fourteen low-molecular-weight hydrocarbons range from 269.2 K for ethane to 385.4 K for cis-2-butene. The reduced limits of superheat range from about 86.7% of the initial temperature for vinyl chloride to about 89.2% for propylene. Plots of the measured limits of superheat for the three mixtures propane–2-methyl propane, ethane–n-propane and ethane–n-butane are reasonably linear in mole fraction. (auth)

**19254** (ANL-8123, pp 18-22) STRUCTURAL STUDIES OF THE $WO_4^{-2}$ AND $MoO_4^{-2}$ IONS IN MOLTEN-SALT MEDIA. Cape, T. W.; Maroni, V. A.; Cunningham, P. T. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

An examination of infrared and Raman spectra of $Mo^{18}O_4^{-2}$ and Raman spectra of $Mo^{18}O_4^{-2}$ dissolved in fused salts demonstrated that the symmetry of the molybdate ion in these solutions is tetrahedral. The isotope substitution technique and the infrared study helped to resolve several anomalous features of earlier Raman investigations of tungstate and molybdate solutions. (auth)

**19255** (ANL-8123, pp 22-25) LASER–RAMAN SPECTRA OF ORGANIC MATERIALS DISSOLVED IN FUSED SALTS. Saturday, K. A.; Maroni, V. A.; Cunningham, P. T. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

Laser–Raman spectra were obtained for pentaerythritol and ethylene glycol dissolved in molten KSCN-NaSCN eutectic. The observed bands correlate with known frequencies for the fundamental modes of the thiocyanate ion and the skeletal modes of the alcohols. The absence of a distinct O–H fundamental in these spectra suggests the occurrence of appreciable hydrogen bonding. (auth)

**19256** (ANL-8123, pp 26-32) LIQUIDUS PHASE DIAGRAMS OF TERNARY RECIPROCAL SALT SYSTEMS. Saboungi, M. L.; Blander, M. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

An empirical extension of the conformal ionic solution theory for ternary reciprocal systems to charge asymmetric systems was made. A comparison of calculations of liquidis phase diagrams for eight systems showed generally satisfactory agreement between the calculations and measurements and brought to light discrepancies in some of the measurements. (auth)

**19257** (ANL-8123, pp 33-40) CONFORMAL IONIC SOLUTION THEORY FOR ADDITIVE TERNARY SYSTEMS. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

Calculations of the conformal ionic solution theory for the additive ternary system AX–BX–CX were carried out to third-order terms. The total excess free energy of mixing, $\Delta A_m^{xs}$ is given by the expression $\Delta A_m^{xs} = \Sigma_{i<j}\Sigma a_{ij}X_iX_j + \Sigma_{i<j}\Sigma b_{ij}X_i^2X_j + cX_1X_2X_3$ where X's are mole fractions of the component i and where i or j = 1, 2, or 3 for the components AX, BX, or CX, respectively. All the coefficients $a_{ij}$, $b_{ij}$, and c for the ternary system can be evaluated from data on the subsidiary binary systems. (auth)

**19258** (ANL-8123, pp 41-42) ON THE CONDENSATION OF BISMUTH, THALLIUM, AND INDIUM FROM A SOLAR NEBULA. Blander, M. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

A careful reexamination and calculation of the thermodynamics and kinetics of condensation of Bi, Tl, and In from a solar nebula indicate that the concept of a "cosmothermometer" and "cosmobarometer" based on these elements, as proposed by Anders and by Larimer, is questionable. (auth)

**19259** (ANL-8123, pp 43-46) CHEMISTRY OF AIRBORNE PARTICULATES. Cunningham, P. T.; Johnson, S.; Yang, R. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

Aerosol samples collected in the city of Chicago were sorted according to size and time of collection and imbedded in KBr pellets for infrared spectral analysis. The most prominent spectral features of submicron particles are ammonium and sulfate ions. Temporal variations in spectra indicate differences in relative amounts of different materials observed and changes in chemistry with time. For example, an acidic sulfate species with a spectrum similar to nitrosylsulfuric acid was observed and might be related to a species intermediate between the gaseous $SO_2$ precursor and $SO_4^{-2}$ in the ammonium sulfate usually found in the submicron aerosol particles. (auth)

**19260** (ANL-8123, pp 47-52) SULFUR EMISSION CONTROL CHEMISTRY. Cunningham, P.; Wilson, W. I.; Johnson, S. A.; Yang, R. Nov 1974.

In Chemical Engineering Division, physical inorganic chemistry annual report, July 1973–June 1974.

A microbalance technique was utilized to measure the rate of reaction of $SO_2 + O_2$ with half-calcined dolomite. The reaction rate is relatively rapid at 750°C and appears to be greater in the presence of water. (auth)

**19261** (COO-3015-11) SEALED-CHAMBER METHOD FOR THE STUDY OF THE RELATIVE AFFINITY OF OXIDE MELTS FOR TRACE MOLYBDENUM AND CESIUM VAPOR SPECIES AT 1100–1300°C. Carmon, B.; Russell, I. J. (Boston Coll., Chestnut Hill, Mass. (USA). Dept. of Chemistry). 15 Jun 1974. Contract AT(11-1)-3015. 43p. Dep. NTIS $5.25.

Molten oxide droplets containing various proportions of $Na_2O$, CaO, $Fe_2O_3$, $Al_2O_3$, and $SiO_2$ were exposed to radioactive vapors of Mo and Cs at 1100° and 1300°C in air in a sealed chamber. Relative absorption values at 1300°C, extrapolated to short times, yield an approximate relationship $(Mo) \propto 1/(Cs)^{\frac{1}{2}}$. The relationship does not apply at 1100°C, below the melting point of most substrates. The relative uptake values of Mo and Cs are strongly related to the composition of the melt, with the oxygen to metal ion ratio playing an important role. Composition sensitivity is somewhat less pronounced at 1100°C, but still significant. The uptake behavior of both tracers can be correlated to the free oxygen ion activity in the substrates. The Mo and Cs apparently behave like a glass-network forming and a glass-network modifying species, respectively. (auth)

**19262** (LA-5850-MS) CHEMICAL EQUILIBRIA IN HOT AIR WITH MOISTURE, SALT, AND VAPORIZED METAL CONTAMINANTS. Zinn, J.; Sutherland, C. D. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1975. Contract W-7405-eng-36. 28p. Dep. NTIS $4.00.

Computations of thermodynamic equilibrium chemical species concentrations in hot (300 to 6000°K) air with and without moisture, salt, and metallic contaminants are described. The importance of the salt and metal vapors stems from the fact that small concentrations can lead to greatly enhanced levels of ionization. Estimated thermodynamic functions are tabulated for 46 different complex molecular and polyatomic ions, and these ions are included in the equilibrium computations. The thermodynamic parameters are used for generating reaction rate coefficients for otherwise uninvestigated reactions which are the reverse of known reactions. (auth)

**19263** (ORO-4682-1) SORPTION OF CESIUM BY GRAPHITES AS A FUNCTION OF STRONTIUM AND BARIUM CONCENTRATION AT HIGH TEMPERATURES. Progress Report for Period May 1, 1974–January 31, 1975. Pyecha, T. D.; Zumwalt, L. R. (North Carolina State Univ., Raleigh (USA)). 1974. Contract AT(40-1)-4682. 13p. Dep. NTIS $4.00.

Three apparatus with associated furnace and monitoring systems for the study of the sorption of cesium by graphite at high temperatures as a function of the concentration of strontium and barium have been constructed, tested, and are now operating satisfactorily. A sorption experiment is underway with H-327 (HTGR) graphite and a satisfactory cesium isotherm has been obtained at 1092 ± 5°C. Another sorption experiment is underway with unimpregnated H-451 ("isotropic") graphite and an experiment with H-451 impregnated with Sr-85 tagged strontium (~ 200 μg/gm) is about to begin. Earlier sorption runs were not completed because of experimental difficulties such as faulty seals and equipment failure. A 50 KVA graphite-tube (King) furnace, for impregnation runs at 1200 to 2000°C, and associated equipment was assembled, debugged and used. Impregnation techniques were developed and the distribution of strontium (and cesium) were roughly determined after diffusion anneals. To obtain insight into the nature of metal-graphite sorption, microscopic studies were begun. This included graphite surface characterization using a JSM-2 scanning electron microscope. Also studies of the micro-distribution of cesium, strontium and barium are underway or planned using (1) an energy-dispersive x-ray analyzer (EDAX), (2) x-ray microradiography, and (3) auto-radiography. (auth)

**19264** ADSORPTION OF RADIONUCLIDE TRACERS FROM AQUEOUS SOLUTIONS ON POLYETHYLENE. Benes, P. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 23-28(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

Results are given of a study in the sorption of all forms of trace elements (simple cations, complex cations, colloids, anions) on polyethylene. The mechanism and the laws guiding the adsorption of traces were found to depend mainly on the state of the trace element or substance in the solution. (INIS)

## Isotope Effects

*Refer also to abstract 19317.*

**19265** THE STABLE ISOTOPES OF OXYGEN IN RESEARCH AND TECHNOLOGY. Staschewski, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Angew. Chem.; 86: No. 11, 387-400(Jun 1974). (In German).

11 figs.; 5 tabs.; 143 refs.

Stable oxygen isotopes prove to be serviceable instruments for research; the application possibilities of these isotopes, however, have only been investigated to a small extent. Five basic types of isotope effects are shown whose investigation and evaluation give a new kind of information on physical, chemical, and biological systems and processes. (GE)

**19266** ISOTOPE SHIFT OF 47–DAY $^{203}$Hg. Redi, O.; Stroke, H.H. (Department of Physics, New York University, New York, New York 10003). J. Opt. Soc. Am. 65: No. 1, 1-5 (Jan 1975).

An improved value of the $^{203}$Hg–$^{198}$Hg isotope shift in the 2537 Å $^3P_1$–$^1S_0$ line of mercury was determined from emission spectroscopy,

with mass–separated samples, and from absorption spectroscopy with unenriched pile–produced isotope. The spectroscopic data were analyzed to yield the isotope shift by use of precise hfs interaction constants that we obtained previously from a level–crossing experiment. The new value for the $^{203}Hg-^{198}Hg$ isotope shift is IS(203–198) = 0.392 ± 0.006 $cm^{-1}$; $^{203}Hg$ lies at the lower–wave–number side. The experiment demonstrates the advantages of absorption spectroscopy for samples of low isotopic purity. The application of this technique to work with small samples is also discussed. Index Headings: Spectra; Mercury. (auth)

**19267** EXPERIMENTAL DETERMINATION OF THE SOLUBILITY OF SMALL ORGANIC MOLECULES IN $H_2O$ AND $D_2O$ AND THE APPLICATION OF THE SCALED PARTICLE THEORY TO AQUEOUS AND NONAQUEOUS SOLUTIONS. Liabastre, A. A. Atlanta; Georgia Inst. of Tech. (1974). 240p. University Microfilms Order No. 75-1088.

Thesis (Ph.D.).

The solubilities of benzene, toluene, pentane, cyclohexane, cyclopentane, cyclopentene, cyclohexene, 1,4-cyclohexadiene, and cycloheptatriene in $H_2O$ and $D_2O$ were determined over the temperature range 278°K to 318°K, using gas-liquid chromatographic techniques. The Henry's Law constants determined from the solubility data were used to obtain the thermodynamic changes associated with the solution process. The thermodynamic properties for the transfer of the solute from $H_2O$ to $D_2O$ have been evaluated. In addition the partial molar volumes of some aromatic alcohols in $H_2O$ have been determined using a magnetic float densimeter. The scaled particle theory of solutions has been extended to evaluate interaction partial molar quantities, solvent and solute hard core diameters, and solvent and solute interaction parameters. Extensive calculations of solution properties of both polar and non-polar solvent systems have been carried out and are reported. The theory has been extended to the solvent $D_2O$ and has been used to predict transfer properties of solutes from $H_2O$ to $D_2O$. Most of the available literature data pertaining to $H_2O$ and $D_2O$ acting as both the solvent and solute are tabulated. The theoretically predicted thermodynamic properties for these and other systems are compared to the experimentally obtained values. Various data correlations have been developed using the scaled particle theory which enable the prediction of thermodynamic solution properties and molecular properties. (Diss. Abstr. Int., B)

**19268** POLYMERIZATION OF VINYL ACETATE RETARDED BY 4-METHYL-2,6-di-tert-BUTYLPHENOL: KINETIC AND ESR STUDIES. Parnell, R. D.; Russell, K. E. (Queen's Univ., Kingston, Ont.). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 2, 347-356(Feb 1974).

4-Methyl-2,6-di-tert-butylphenol strongly retards the free radical polymerization of vinyl acetate initiated by azobisisobutyronitrile. The chain transfer constant, estimated from rate data, is 0.020 ± 0.004 at 35°C and does not vary significantly with temperature. Molecular weight data lead to transfer constants of 0.023, 0.020, and 0.024 at 35, 45, and 55°C, respectively. A mean kinetic isotope effect of 9.8 ± 1.0 is observed for the phenol deuterated at the OH group, showing that the main attack of poly(vinylacetate) radicals on the phenol involves hydrogen abstraction from this group. The activation energy for hydrogen abstraction is estimated to be 7.8 kcal/mole, and the rate constant at 50°C is 160 ± 40 l/mole-sec. The stationary concentration of 4-methyl-2,6-di-tert-butylphenoxyl in the polymerization mixture is proportional to the phenol concentration and is independent of the initiator concentration, as shown by electron spin resonance studies. Cross termination of poly(vinyl acetate) and phenoxy radicals occurs to a greater extent than mutual termination of these radicals. The rate constant for cross termination is close to $1 \times 10^8$ l/mole-sec at 50°C; the activation energy for cross termination is 2.9 ± 1.3 kcal/mole. (auth)

**19269** CYCLOTRIMERIZATION OF ACETYLENE BY THE TRIS(ACETYLACETONATO)TITANIUM(III)–DIETHYLALUMINUM CHLORIDE SYSTEM. Shirakawa, H.; Ikeda, S. J. Polymer Sci., Polym. Chem. Ed.; 12: No. 5, 929-937(May 1974).

Reaction of acetylene with tris(acetylacetonato)titanium(III) and diethylaluminum chloride system leads to formation of benzene, a trace of ethylbenzene, and a small amount of polyacetylene. The isotopic composition of products obtained from cyclotrimerization of acetylene-$d_2$ and an equimolar mixture of acetylene and acetylene-$d_2$ was investigated to elucidate the mechanism of the cyclotrimerization. The results suggest a mechanism in which an acetylene inserts into the metal–ethyl bond formed by reaction of $Ti(acac)_3$ and $Al(C_2H_5)_2Cl$, followed by insertion of two acetylene molecules and elimination of a hydrogen atom from the first inserted acetylene to yield an ethylbenzene and a metal hydride intermediate. The metal hydride intermediate catalyzes acetylene cyclotrimerization to give benzene. During the reaction, the hydrogen atom in the metal hydride intermediate does not exchange with the hydrogen atom in the inserted acetylene molecules. (auth)

**19270** CHLORINE ISOTOPE EFFECT STUDY OF NUCLEOPHILIC SUBSTITUTION REACTIONS IN PROTIC AND APROTIC MEDIA. Reppond, K. D. Fayetteville, AK; Univ. of Arkansas (1974). 224p. University Microfilms Order No. 74-28,087.

Thesis (Ph.D.).

A kinetic and chlorine-37 kinetic isotope study of nucleophilic displacement reactions of a series of p-substituted benzyl chlorides was carried out in 97% aqueous methanol and in DMF. A Hammett sigma-plus plot of the kinetic results shows distinct curvature for the reactions indicating a changing mechanism. The reaction is shifted away from the borderline with the $S_N1$ mechanistic region by substituents with electron withdrawing groups as noted by others for the reactions of benzyl chlorides. The kinetic isotope effects for reactions in DMF were higher than for corresponding reactions in aqueous methanol, indicating that specific solvation of the developing chloride ion lowers the chlorine isotope effect. The kinetic isotope effects for reactions with a given nucleophile are generally highest when the para substituent is the most efficient electron donating group in the series, and lowest when the para substituent is the most efficient electron-withdrawing group. The dependence of the kinetic isotope effect on the identity of the added nucleophile did not correspond with basicity of the nucleophilic anion, but did correlate with the rate constant (i.e., the larger the rate constant, the lower the isotope effect). This was interpreted as indicating that the degree of C–Cl bond rupture in the transition state is inversely proportional to the reactivity of the nucleophile. A series of theoretical isotope effect calculations was carried out within the framework of the transition state theory employing appropriate cut-off models for the reactant and $S_N1$ and $S_N2$ transition states. These calculations show that the trends, if not the exact values, of the experimental isotope effects can be reproduced using reasonable models and molecular parameters. Models representing activated complexes in which the developing chloride ion is specifically solvated were studied and the related isotope effects were substantially lower than the corresponding isotope effects of the corresponding unsolvated models. These results reaffirm the idea that leaving group isotope effects can be of significant value in elucidating the mechanisms of nucleophilic substitution reactions. (Diss. Abstr. Int., B)

**19271** THE DESORPTION OF HYDROGEN FROM POLYCRYSTALLINE Ni-ADSORBED LAYERS. Benndorf, C.; Thieme, F. (Hamburg Univ. (F. R. Germany). Inst. fuer Physikalische Chemie). Z. Phys. Chem. (Frankfurt); 87: No. 1/3, 40-59(Nov 1973). (In German).

The thermal desorption of hydrogen adsorbed by nickel films was investigated by means of mass spectrometry under uhv conditions in the range of 80 to 440°K. The desorption spectra of the $\beta$-state as measured obey second order kinetics. The activation energy decreases with increasing coverage. Values of the activation energy of desorption, of the energy of lateral interaction of the adsorbed particles and values pertaining to the pre-exponential factor will be gained from the adaptation of theoretical models to the experimental values as well as from the shift of the desorption maximum with increasing coverage towards lower temperatures and from Arrhenius plots of the pressure-temperature curves. The mass spectra of the desorption of $D_2/H_2$-mixtures show a nearly complete exchange in the state of chemisorption, which is in agreement with statistical expectations, whereas the isotope concentrations of the desorbate from the phase of physisorption occurring before chemisorption suggest a molecular state of adsorption. (auth)

## *Isotope Exchange and Isotope Separation*

*Refer also to abstracts 19215, 19225, 19241, 19242, and 19669.*

**19272** (JUL-974-AC) THE $H_2{}^{18}O$ ENRICHMENT IN THE LEAVES OF TRANSPIRING PLANTS AND ITS IMPORTANCE FOR THE STATIONARY $^{18}O$ SUPERELEVATION IN THE ATMOSPHERE. Dongmann, G.; Nuernberg, H. W.; Wagener, K. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Zentralinstitut fuer Analytische Chemie; Technische Hochschule Aachen (F. R. Germany)). Jul 1973. 86p. (In German). INIS.

Thesis by G. Dongmann, Technische Hochschule Aachen, F. R. Germany.

The fraction of photosynthesis of land plants dependent on the DOLE effect was determined. This contribution can be traced back to three partial effects, the isotope effect in the biochemical process of photosynthesis, the $H_2{}^{18}O$ enrichment in leaf water relative to the ground water, and the enrichment of the ground water compared with seawater. The relative $^{18}O$ frequency in

leaf water was investigated by means of a mass spectrometer. The margin of error of the method including the sample preparation was 0.3 per thousand for water and 0.2 per thousand for oxygen. Diurnal variations of $H_2{}^{18}O$ enrichment in leaves of a beech, an oak and of two brasilian trees as well as the corresponding meteorological parameters were measured. The experiments showed that the $H_2{}^{18}O$ concentration in the leaves has a linear correlation to the relative air humidity and air temperature but not to the wind velocity. As no oxygen isotope fractionation occurs in the photosynthesis itself, the same mathematical interrelationships are also valid for the $^{18}O$ concentration of the photosynthesis oxygen. As the DOLE effect is clearly determined by the isotope effect and conversion rates of the individual processes (photosynthesis, respiration, exchange), one can calculate, from its actual value and the single effects, the oxygen exchange rate between atmosphere and sea which is an important parameter for ecological problems. (GE)

**19273** METHODS OF INVESTIGATING ISOTOPE EXCHANGE REACTIONS. Gosman, A. (Ceske Vysoke Ucenl Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 17-22(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The principles of isotopic exchange reactions as well as their importance for the solution of chemical, biological, and physical problems are described. Methods are presented of investigating isotopic exchange requiring analytical separation of the system components, such as experimental determination of isotopic exchange parameters, and methods of investigating isotopic exchange without the need of analytical separation of the system components, suitable for determination of exchange half-lives. Also discussed is the study of very rapid exchange reactions with the separation of components and a possibility of determining half-lives as short as one second. (INIS)

**19274** THERMAL TRANSCARBOXYLATION REACTIONS. IV. Study of the Carboxyl Group Exchange Reaction. Szammer, J.; Szabolcs, A.; Noszko, L. (Central Research Inst. for Chemistry, Budapest). Radiochem. Radioanal. Lett.; 20: No. 2, 151-158(17 Jan 1975).

The isotopic tracer technique was applied to the study of carboxyl group exchange reaction. It was established that the exchange reaction proceeds with thermally stable salts in the presence of unstable ones but does not occur in the absence of $\alpha$-hydrogen. (auth)

### *Feed Materials Processing*

**19275** (NP-20305) EXPERIMENTAL DETERMINATION OF THE DESIGN PARAMETERS OF A FLUIDIZED BED. Manriquez, J. R. (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Quimica). 1974. 241p. (In Spanish). Dep. NTIS (US Sales Only) $15.25.

Thesis.

The design parameters of a fluidized bed for the production of $UO_3$, $UF_4$, and $UF_6$ were studied. A comparative study was made of the fluidization variables of the trioxide and dioxide of U when there is a horizontal or vertical vibration of the bed. The study was made in order to determine the advantages, disadvantages, and their justification in the design of a continuous fluidized bed reactor. The most important variables studied were porosity, minimum fluidization rate, total fluidization rate, sphericity, and friction factor. (tr-auth)

## Radiation Chemistry

*Refer also to abstracts 19616 and 20601.*

**19276** (AD-784383) INFRARED EMISSION OF SOME MOLECULAR GASES EXCITED BY FAST ELECTRONS. Koval, A. G.; Koppe, V. T.; Fogel, Ya. M. Translated from Probl. Kosm. Fiz.; No. 4, 112-133(1969). 28p. (FSTC-HT-23-1301-73).

The infrared spectra (spectral region 7000-11,500 Å) of $N_2$, $O_2$, CO, $CO_2$, NO, $CH_4$, $NH_3$, $H_2O$ molecules excited by fast electrons with energy of 13 keV were investigated. Nitrogen spectrum was also investigated at the energy 150 eV. The spectra were compared with the spectra of the same gases excited by slow electrons and protons. Assignments and features are discussed. (GRA)

**19277** (AED-CONF-74-440-001) SENSITISED PHOTOLYSIS AND RADIOLYSIS OF NUCLEOSIDES. Hinsch, H.; Scheel, H. E. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik). 1974. 5p. (In German). (CONF-741068-1). INIS.

From annual meeting of the German Biophysic Society; Freiburg im Breisgau, F. R. Germany (2 Oct 1974).

Nucleosides in aqueous, oxygen-containing solution are oxidized by light effect when the solution simultaneously contains a dye (so-called photodynamic effect). The reaction mechanisms for the system methylene blue or cosine/guanosine were investigated by means of pulse photolysis and the reaction constants determined. The results are compared with simultaneously carried-out pulse radiolysis experiments. The details of the energy transfer mechanism are discussed, in particular regarding analogies between the effects of both excitation methods. (GE)

**19278** (ANL-Trans-975) HYDRATED ELECTRON I CONFIGURATION MODEL. Byakov, V. M.; Klyachko, B. S.; Ovlunnikov, A. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). Feb 1975. Translation of pp. 1-54 of ITEF-27. 55p. Dep. NTIS $5.75.

In determining the real structure of water, a configuration model of the hydrated electron is proposed in the form of a charged $(H_2O)_7^-$ cluster with $C_{2v}$ symmetry. In contrast to previous models, all the possible equilibrium configurations of the immediate surroundings of the electron, that is, equilibrium configurations of the $(H_2O)_7^-$ cluster, were determined. Considering this, a band of photo-transition energies (optical absorption band) was obtained for the hydrated electron. Experimental values of the photo-transition energy lie within the calculated field. It was indicated that the energy of the electron bonding in an activated condition is small in comparison with the thermal energy of water molecules. (auth)

**19279** (BNWL-B-17) EFFECTS OF RADIOLYSIS OF B PLANT EXTRACTION COLUMN RAFFINATES. Schulz, W. W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1 Jan 1971. Contract AT(45-1)-1830. 16p. Dep. NTIS $4.00.

B Plant extraction column raffinate solutions prepared from reagent-grade chemicals and containing various organic complexing agents were irradiated ($^{60}Co$) to absorbed doses in the range 110 to 840 watt-hr/liter. Extraction column raffinate (citrate-complexed was also prepared from actual plant Purex Acid Waste (PAW) and allowed to stand three weeks until the absorbed radioactive decay energy (from the radionuclides in the PAW) amounted to about 200 watt-hr/liter. Compositions of these raffinates were selected to simulate those expected if none of the strontium and rare earths were removed in extraction column operation. Physical and chemical properties of the irradiated raffinates were measured to devise feed adjustment procedures to permit satisfactory extraction column rework for recovery of strontium and rare earths. The pH of all raffinates increased from 2 to 3.6 pH units after irradiation to about 800 watt-hr/liter; pH changes were proportionately smaller at lower exposure levels. Solids did not precipitate from raffinates containing either citrate or HEDTA at any of the irradiation doses tested; however, brown solids, tentatively identified as hydrated iron (III) oxide, precipitated from NTA-complexed raffinate when irradiated to 840 watt-hr/liter. For solvent extraction rework purposes a satisfactory feed adjustment procedure is to add both $HNO_3$ and the appropriate complexing agent to the irradiated raffinate. Nitric acid serves to adjust the pH of the raffinate to approximately its original value. Buffering and complexing capacities lost by radiolysis are restored by addition of the appropriate complexing agent. Over a wide range of complexants and irradiation doses this feed adjustment procedure provides material suitable for the recovery of strontium and rare earths at controlled pH with only minimal extraction of undesired components. (auth)

**19280** (JAERI-M-5838) MECHANICAL STRENGTH AND THERMOSTABILITY OF HIGH POLYMERS. Radiation Effects on the Capsule Materials. Horiguchi, Y.; Miyauchi, T.; Yamamoto, A. (Japan Atomic Energy Research Inst., Tokyo). Sep 1974. 26p. (In Japanese). Dep. NTIS (US Sales Only).

The changes in mechanical strength and the thermostability of high polymers as capsule material, after exposure to Co-60 gamma rays and reactor radiation, were investigated. Thermostability was measured by measuring the activation energy in thermal oxidation reaction by DTA-TGA (differential thermal analysis and thermogravimetric analysis), and mechanical strength was determined by tensile and destructive tests. From these results, integrity of such capsules was evaluated. Cautions to be taken in usage of the capsules are also described. (auth)

**19281** (JPRS-63303) TRANSLATIONS ON EASTERN EUROPE. 29 Oct 1974. Translation of Scientific Affairs No. 435. 26p. NTIS.

Eight articles are included; one is abstracted and indexed separately for NSA. (JGB)

*For an abstract of an individual section see: 19282.*

**19282** (JPRS-63303, pp 12-16) EFFECTS OF NUCLEAR EXPLOSION ON POLYMERIC MATERIALS. Petkov, V. 29 Oct 1974. Translated from Voenna Tekhnika; No. 7, 28(1974).

In translations on eastern Europe.

In order to determine the effects of nuclear explosions on polymers at various distances from the blast, experiments were conducted using simulated conditions. Samples of polyethylene, silicone rubber, Se-30 silicone elastomer, bakelite, polyester granules, and high-temperature Apiezon-M lubricating oil were irradiated with uv rays in the 280 to 410 nm range, then placed in a furnace preheated to a high temperature. Radiation exposures were for periods of 2, 4, and 8 sec, which correspond to the length of the light pulses of explosions with a power of 20, 75, and 250 kilotons. Results on the extent of carbonization, depolymerization, weight loss, and softening of the materials are given. (JGB)

**19283** (LBL-2727) KINETICS OF RADIOLYTIC GAS PHASE REACTIONS BY MODULATED MOLECULAR BEAM MASS SPECTROMETRY. Kruger, V. R. P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1974. Contract W-7405-eng-48. 128p. Dep. NTIS $9.50.

Thesis.

An experimental system was developed to enable on-line mass spectrometric analysis of gas phase radiolysis flow systems, and was applied to observation of the oxygen radiolysis system in particular. In this experimental system, energy from a beam of 1-MeV protons is deposited in the oxygen as it flows through a fast-flow reaction tube. A molecular beam source samples the flow gas, and the resulting molecular beam is then modulated and analyzed with a quadrupole mass spectrometer. Experimentally determined quantities are the concentrations of atomic oxygen, molecular oxygen, and ozone as functions of reaction time, system pressure, and total absorbed dose. Operating parameters were in the following ranges: system pressure, [1.5 - 4.0] Torr; irradiation time, [0.2 - 0.3] sec; total energy deposited, [0.5 - 15] $10^{12}$ heV/cm$^3$; dose rate, [0.2 - 20] $10^{20}$ heV/gm·sec. Observed concentrations of the radiolysis products atomic oxygen and ozone were of the order: atomic oxygen, [5 - 40] $10^{12}$ atoms/cm$^3$ and ozone, [3 - 20] $10^{13}$ molecules/cm$^3$. The ozone levels observed are substantially higher than those predicted by pre-existing chemical models, and the discrepancies cannot be explained in terms of increased g-values or of systematic errors in the measurement. A modification to the chemical model is proposed, in which an excited vibrational state $O_2$• is postulated as a precursor to ozone via the reaction: $O_2$• + $O_2$ → $O_3$ + O. Calculations including this modification indicate that agreement with the data is improved, although neither the agreement nor the explanation can be considered complete. It is concluded that further investigation of the low-pressure behavior in the oxygen radiolysis system is indicated, particularly with regard to the role of excited species in the chemical mechanism. (auth)

**19284** (UR-3490-660) ELECTRON SPIN RESONANCE STUDIES OF FREE RADICAL FORMATION IN IRRADIATED SINGLE CRYSTALS OF 1-METHYLCYTOSINE, 5-FLUOROURACIL, AND A MOLECULAR COMPLEX CONTAINING 1-METHYLCYTOSINE AND 5-FLUOROURACIL. Farley, R. A. (Rochester Univ., N. Y. (USA)). 1974. Contract AT(11-1)-3490. 122p. Dep. NTIS $9.25.

Thesis.

This study was undertaken to investigate free radical formation in single crystals of nucleic acid components. Irradiated single crystals of the base-paired complex formed between 1-methylcytosine and 5-fluorouracil and single crystals of 1-methylcytosine and 5-fluorouracil were examined in the temperature range 77–300°K using electron spin resonance. (auth)

**19285** OPTICAL ABSORPTION SPECTRA OF A SOLVATED AND STABILIZED ELECTRON IN ALIPHATIC ALCOHOLS. Vannikov, A. V.; Rudnev, A. V.; Zimina, G. M. (Inst. of Electrochemistry, Moscow). Radiat. Eff.; 23: No. 1, 15-20(Sep 1974).

Irradiation of alcohol glass at a low temperature is known to cause its coloring, which is attributable to stabilization of electrons ($\bar{e}_{tr}$). By a pulse radiolysis method, short-life spectra of solvated electrons ($\bar{e}_s$) in liquid alcohols can be detected. The absorption spectra $\bar{e}_s$ exhibit a considerable half-width ≃1.0 to 1.5 eV, yet up to now this fact has not been explained satisfactorily. The work now reported studies the form of the spectrum of optical absorption in isopropanol and isopentanol at 300, 135, and 77°K. Electron pulses were used for the measurements of the spectra at 300 and 135°K; gamma radiation was used to irradiate the glassy alcohols at 77°K. The results are discussed. (UK)

**19286** γ-RADIOLYSIS OF AQUEOUS SOLUTIONS OF INDOLE-3-ACETIC ACID. II. Shetiya, R. S.; Rao, K. N.; Shankar, J. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 23: No. 1, 7-14(Sep 1974).

In the γ-radiolysis of aqueous solutions of indole-3-acetic acid (IAA), G(-IAA) was found to decrease with the absorbed dose in aerated and deoxygenated solutions. In the presence of OH radical scavengers, G(-IAA) was not negligible indicating thereby that OH radicals alone are not responsible for IAA decomposition as had been postulated earlier. Radiolytic products of IAA are mainly indole derivatives with some of their properties similar to those of IAA. The uv spectra of irradiated IAA solutions showed a very interesting behavior in that three isobestic points were observed and absorption at 245 nm showed an increase with increasing dose. $R_F$ values, color reactions and spectral characteristics of some of the products are presented. (auth)

**19287** HIGH-ENERGY REACTIONS OF CARBON. Lemmon, R. M.; Erwin, W. R. Sci. Amer.; 232: No. 1, 72-80(Jan 1975).

High-energy carbon reactions, which have been studied in an attempt to gain an understanding of key organic reactions promoting the emergence of life on our planet, are discussed. Analysis of the products of such reactions gives insight into the mechanism by which high-energy carbon atoms form new carbon compounds. Various methods of producing these reactions are discussed, with emphasis being placed on studies in which carbon atoms are accelerated in an electrostatic field and aimed at selected target molecules. It was found that an accelerated $^{14}C$ ion reacts with benzene to yield benzene incorporating $^{14}C$. Although other major products, including toluene, cycloheptatriene, and phenylacetylene, have been identified, many minor products have not been identified. (JGB)

**19288** EXPERIMENTAL AND THEORETICAL STUDIES OF RADIATION-PRODUCED RADICALS. Lee, J. Y. Buffalo; State Univ. of New York (1974). 122p. University Microfilms Order No. 75-1497.

Thesis (Ph. D.).

A study of paramagnetic species produced by ionizing radiation has been carried out which includes theoretical as well as experimental aspects. The characteristics of α-proton and β-proton anisotropic hyperfine coupling tensors of radiation-damaged biological molecules were analyzed theoretically. The experimental aspects of this thesis include an investigation of single crystals of DL-serine and glycylglycine HCl, x-irradiated at 4.2°K, by ESR and ENDOR spectroscopy. In both molecules, the carboxylic anion species resulting from electron attachment to the carbonyl oxygen of the carboxyl group has been identified. On the oxidation side the species resulting from decarboxylation has also been identified. In glycylglycine HCl the peptide anion resulting from electron attachment to the carbonyl oxygen of the peptide group is also formed as a reduction product. In DL-serine a species resulting from the severance of the hydrogen of the hydroxy group has been discovered. This is a novel radiation product which is unstable at 4.2°K and decays slowly due to a process of hydrogen migration. The aforementioned theoretical analysis of hyperfine coupling tensors proved useful in the identification of these species from the ESR and ENDOR spectra (LK)

**19289** PHOTOCHEMISTRY OF POTASSIUM TRISOXALATOFERRATE(III) TRIHYDRATE IN THE SOLID STATE. Savelyev, G. G.; Medvinskii, A. A.; Shtsherinskii, V. L.; Gevlitch, L. P.; Gavryusheva, N. I.; Pavlyukhin, Yu. T.; Stepanova, L. I. (Polytechnic Inst., Tomsk, USSR). J. Solid State Chem.; 12: No. 1-2, 92-101(1 Jan 1975).

The gaseous and solid state products of decomposition on uv exposure of polycrystalline $K_3[Fe(C_2O_4)_3]\cdot 3H_2O$ were investigated by mass spectrometry, ir and Mössbauer spectroscopy, and chemical and x-ray phase analysis. $CO_2$ and CO are obtained as photoproducts. The volume ratio, $CO:CO_2$, generated depends on the exposure conditions and approximately equals 1:3 on photodecomposition in air and 1:2 on decomposition in vacuum. Comparison of the experimental and literature data leads to the following conclusions. The Fe(II)-containing final products of photolysis, radiolysis, and low-temperature (250 to 260°C) thermal decomposition are identical; $FeC_2O_4$ is missing among the principal final solid state products. Arguments are presented in favor of the view that the Fe(II)-containing final products of photodecomposition is a polymer of composition $(K_2[Fe(C_2O_4)_2])_n$. On the basis of the experimental and literature data, the flow sheet and stoichiometry of the photodecomposition has been determined. A comparison is made of the spectral dependences of photoconductivity and of photolysis in air. The type of charge carrier is established. Questions related to the mechanisms of photodecomposition are discussed. (auth)

**19290** RADIATION-INDUCED BINDING OF OH-SUBSTITUTED AROMATIC AMINO ACIDS, TYROSINE AND DOPA, MUTUALLY AND WITH ALBUMIN IN AQUEOUS SOLUTION. Yamamoto, O. (Hiroshima Univ.); Okuda, A. Radiat. Res.; 61: No. 2, 251-260 (Feb 1975).

Gamma-radiation-induced binding of tyrosine and dopa with albumin and mutually with each other was studied and compared with that of phenylalanine in aqueous solution. With albumin, these three amino acids were bound to the same degree in neutral solution, but in acid solution the binding yield decreased with decreasing numbers of OH groups on the aromatic ring. Increasing the number of OH groups lessened the effect of OH radical scavengers on the binding yield in neutral solution. Chromatographic studies of irradiated amino acid solutions showed the formation of a dimer-like product, but melanine was not formed. By the ninhydrin reaction, a radiation-induced modification of the aromatic amino acids much greater than the degradation of the alanyl side chain was observed in both $N_2$ and $O_2$ saturated solutions. The formation of phenoxyl type radicals does not appear to be due to the reactions of OH and $e_{aq}^-$. The substitutional binding of phenoxyl- and phenyl-type radicals, produced in different ratios to aromatic rings of other molecules, was suggested as the binding mechanism of tyrosine and dopa. (auth)

**19291** EFFECT OF TEMPERATURE ON THE RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN VARIOUS MEDIA. Wada, T.; Watanabe, T.; Takehisa, M.; Machi, S. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 8, 1585-1608(Aug 1974).

The effects of temperature on the radiation-induced polymerization of ethylene in bulk and in the presence of ethyl alcohol, n-butyl alcohol, tert-butyl alcohol, cyclohexane, 2,2,4-trimethylpentane, and 2,2,5-trimethylhexane were studied. The changes of the amounts of polymerized monomer with the reaction temperature were different from each other in these reaction systems, especially in the range lower than 60–80°C. At temperatures lower than 60–80°C, as the reaction temperature increases, the amount of polymerized monomer decreased in bulk and in the presence of tert-butyl alcohol. The amount was almost constant in the presence of ethyl alcohol and 2,2,4-trimethylpentane, and it increased in the presence of n-butyl alcohol, cyclohexane, and 2,2,5-trimethylhexane. However, in the temperature range higher than 60–80°C, the amount of polymerized monomer increased with increasing temperature in every reaction system except for bulk polymerization. The molecular weight of polymer decreased with increasing temperature in every reaction system except at temperatures lower than 25°C. The molecular weight of polymer formed in bulk, in tert-butyl alcohol, and also in 2,2,4-trimethylpentane were relatively higher than that in other reaction systems. A bimodal molecular weight distribution was observed for the polymer formed in bulk and in tert-butyl alcohol at 40–60°C. These results are discussed in connection with the heterogeneity of the reaction system. The differences due to temperature in each reaction system are explained as due to the difference in affinity of the reaction system for the propagating chain and in the facility of chain transfer to the medium. (auth)

**19292** RADIATION-INDUCED HOMOGENEOUS POLYMERIZATION OF ETHYLENE IN CYCLOHEXANE. Watanabe, T.; Wada, T.; Takehisa, M.; Machi, S. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 8, 1609-1618(Aug 1974).

The radiation-induced polymerization of ethylene in cyclohexane was carried out in a reactor of 100 ml capacity under a range of temperature of 25–150°C, dose rate of $4.1 \times 10^4$–$2.9 \times 10^5$ rad/hr, pressure of 200 kg/cm$^2$, and amount of cyclohexane of 20–90 ml. The polymerization was found to proceed at a steady state from the beginning. The polymerization rate is maximum at ca. 50 ml of cyclohexane. The dose rate exponent of the polymerization rate was 0.6 at every temperature from 25 to 150°C. The polymer molecular weight is in the range of $10^3$–$10^4$, independent of dose rate, and decreases with increasing amount of cyclohexane. The molecular weight distribution is unimodal and narrow. Kinetic analysis of these results indicates that the polymerization proceeds via a simple scheme of homogeneous polymerization and the polymer molecular weight was determined by the chain transfer reaction which takes place mostly with cyclohexane. The unimodal and narrow molecular weight distribution is also consistent with the homogeneous polymerization scheme. (auth)

**19293** NOVEL SCHEME OF HETEROGENEOUS POLYMERIZATION OF ETHYLENE. Watanabe, T.; Wada, T.; Takehisa, M.; Machi, S. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 8, 1619-1628(Aug 1974).

The heterogeneous polymerization of ethylene initiated by radiation in tert-butyl alcohol was studied. The polymerization was carried out in a 100-ml reactor at 25–100°C and pressures of 200–300 kg/cm$^2$ in the presence of 50 ml of tert-butyl alcohol containing 7 wt% water. The amounts of polymerized monomer, the average molecular weight of polymer formed, and the molecular weight distribution of polymer were measured at various stages of reaction and at various temperatures. The molecular weight distribution was found to be very much dependent on the reaction time and temperature. For the polymer formed at 50–60°C in the very early stages of reaction, the molecular weight distribution is unimodal, and in the intermediate stage a shoulder appears at a molecular weight higher than the first peak which increases as the polymerization proceeds; eventually a bimodal curve is formed. The bimodal distribution curves were analyzed to determine the fractions and average molecular weights of each peak. On the basis of these data for the molecular weight distribution and kinetic behavior, a new scheme for the heterogeneous polymerization is proposed which indicates that the polymerization proceeds via propagating radicals in two different physical states, namely, loose and rigid states. (auth)

**19294** RADIATION-INDUCED HETEROGENEOUS POLYMERIZATION OF METHYL METHACRYLATE IN PRECIPITANTS. Wada, T.; Takehisa, M.; Machi, S. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 8, 1629-1646(Aug 1974).

The radiation-induced heterogeneous polymerization of methyl methacrylate in various precipitants, mainly methyl alcohol, was carried out, and the effects of reaction conditions on the polymerization behavior and the molecular weight distribution of polymer were studied. Bimodal molecular weight distributions were found for the polymer produced by the heterogeneous polymerizations in methyl alcohol and in tert-butyl alcohol. The apparent activation energy is 1.0 and 4.5 kcal/mole, respectively, for the polymerization at a monomer concentration of 10 vol% in methyl alcohol above and below 35°C. The polymerization at a monomer concentration lower than 40 vol% in methyl alcohol proceeded with the precipitation of polymer. The dose rate exponent of the mean rate of heterogeneous polymerization decreased from 0.5 to a smaller value as the polymerization progressed. The ratio of the two peaks in the bimodal molecular weight distributions of polymer produced in methyl alcohol was affected by the reaction conditions. These results show the coexistence in the polymerizations of two different physical states of propagating chain, a loose state and a rigid one. The reaction scheme is discussed in connection with the physical factors which affect the solubility or the mobility of propagating chains, and the rate of elementary reactions, which influences the degree of propagating chains. (auth)

**19295** ELECTRON SPIN RESONANCE STUDIES ON RADIATION GRAFT COPOLYMERIZATION. I. Grafting Initiated By Alkyl Radicals Trapped in Irradiated Polyethylene. Seguchi, T.; Tamura, N. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 8, 1671-1682(Aug 1974).

The behavior of trapped radicals in polyethylene, which is irradiated in air at room temperature, under grafting of methyl methacrylate or butadiene has been studied by electron spin resonance. Part of the alkyl radicals are converted to allyl radicals by reaction with double bonds and the others disappear by recombination under vacuum. The active species of grafting are alkyl radicals when the vapor pressure of monomers is relatively high, while at low pressure allyl radicals also play a role as well as alkyl radicals. In the grafting at 20°C, the grafting yields depend mainly on the decay rate of alkyl radicals which come out of the crystalline regions of polyethylene. The decay rate of alkyl radicals and the rate of grafting at the initial stage increase with decreasing crystallite size of polyethylene. (auth)

**19296** RADIATION-INDUCED IONIC POLYMERIZATION OF ISOBUTYL VINYL ETHER IN BULK. de Plessis, T. A.; Stannett, V. T., Goineau, A. M. (North Carolina State Univ., Raleigh). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 11, 2457-2466(Nov 1974).

The radiation-induced ionic polymerization of isobutyl vinyl ether was investigated under conditions where the monomer was dried with molecular sieves. The investigation covered the temperature range from −16°C to 90°C, and the dose-rate range from $10^{15}$ to $10^{20}$ eV/g-sec, using both γ-rays and electrons. A very high overall activation energy of 15.9 kcal/mole was found for the process below 30°C. Above 30°C, however, the value of the overall activation energy dropped to 4.9 kcal/mole, a phenomenon which is ascribed to the solvation of the propagating carbonium ion below 30°C. The dose-rate dependence of the rate of polymerization was found to be 0.58 over the entire dose-rate range investigated. The molecular weight of the polymer was found to be far less sensitive to trace amounts of water than the rate of polymerization. The molecular weight of the polymer depended strongly on the irradiation temperature, reaching a maximum value of about 120,000 at 35°C. It is shown that at temperatures above 20°C regenerative chain transfer processes play an important role in determining the molecular weight of the polymer. (auth)

**19297** FURTHER STUDIES ON THE ULTRAVIOLET GRAFT COPOLYMERIZATION OF MALEIMIDE BY VAPOR-PHASE METHOD. Hayakawa, K.; Kawase, K.; Yamakita, H. (Government Industrial Research Inst., Nagoya). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 11, 2603-2612(Nov 1974).

Graft copolymerization of maleimide onto polyethylene and ethyl cellulose films by using its sublimation vapor was carried out under ultraviolet irradiation in the presence or absence of air; the effect of air or additives on the grafting reaction and on the nature of the grafted films was investigated. The extent of grafting gradually approached a fixed value, in spite of the continuous ultraviolet irradiation. Air retarded the grafting reaction but did not suppress the reaction nor alter the final extent of grafting. Benzoquinone showed no inhibiting effect on the grafting. The grafted polymaleimide was found to be amorphous, even though ultraviolet irradiation produces a highly crystalline homopolymer in the solid phase as well as in the liquid phase. The results were discussed in comparison with those of the vapor-phase grafting under $\gamma$-ray irradiation; the reaction is attributed to the vapor-crystal equilibrium of monomer and to the formation of short-chain crosslinks. (auth)

**19298** EFFECTS OF ADDITIVES ON THE RADIATION-INDUCED EMULSION COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH PROPYLENE. Suzuki, N.; Okamoto, J. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 11, 2693-2696(Nov 1974).

The effects of added organic chloride, alcohols, and radical polymerization inhibitors on the radiation-induced emulsion copolymerization of tetrafluoroethylene with propylene were studied. The emulsion system was irradiated with $\gamma$-rays from a $^{60}Co$ source at room temperature. Conversion was not affected by addition of hexachloroethane and 1,1,2-trichloro-1,2,2-trifluoroethane, but addition of $CCl_4$ decreased it. The molecular weight was not affected by addition of 1,1,2-trichloro-1,2,2-trifluoroethane, but it decreased markedly on the addition of hexachloroethane and $CCl_4$. Addition of a small amount of alcohol (isopropyl, methyl, and ethyl) decreased conversion; the molecular weight was not affected. Conversion was inhibited completely by the addition of DPPH and p-benzoquinone. (LK)

**19299** RADIATION-INDUCED CROSSLINKING AND CYCLIZATION IN 1,2-POLYBUTADIENE. von Raven, A.; Heusinger, H. (Technische Univ., Munich). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 10, 2225-2271(Oct 1974).

In order to get information on the radiolytic changes in 1,2-polybutadiene (1,2-PB) the sol and gel fractions, the conversion of double bonds, the structure and concentration of radicals, the formation of dienes and the formation of gaseous products were measured. In addition, the dose rate dependence and temperature dependence for the conversion of double bonds were determined. G values for double bond conversion depend on molecular weight and range from 20 to 200. G values for crosslinking are about 10. A mechanism for the double bond conversion is proposed which involves initiation by a transformation of the primary radical ion in the vinyl group into a carbonium ion and a radical. This is supported by ESR measurement. Reaction of the carbonium ion with a vinyl group in the same chain gives rise to cyclization, whereas reaction with a vinyl group in a neighboring chain results in crosslinking. A comparison of the G values for conversion of double bonds with the G values for crosslinking shows that the formation of cyclic rings exceeds the formation of crosslinks by a factor of about 10. The corresponding values in 1,4-cis- and 1,4-trans-polybutadiene are much smaller [G(cl) $\simeq$ 2; G(db) $\simeq$ 7]. The pendent vinyl groups in 1,2-polybutadiene therefore are more reactive than the vinylidene groups in 1,4-polybutadienes. (auth)

**19300** STEREOREGULARITY AND POLYMERIZATION MECHANISM OF POLYMETHACRYLONITRILES DETERMINED BY $^{13}C$-NMR SPECTROSCOPY. Matsuzaki, K.; Kanai, T.; Matsumoto, S. (Univ. of Tokyo). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 10, 2377-2384(Oct 1974).

Carbon-13 nuclear magnetic resonance ($^{13}C$-NMR) spectra of polymethacrylonitriles prepared under various conditions were measured. In acetone solution, the $\alpha$-methyl carbon absorptions were split into triads and partially into pentads, and the methylene carbon absorptions into tetrads. In trifluoroacetic acid solution, the $\alpha$-methyl carbon absorptions were split into pentads and the cyano carbon absorptions into triads. The triad, tetrad, and pentad tacticities determined from $^{13}C$-NMR spectra were compared with dyad tacticities determined from proton NMR spectra. The stereoregularity of the polymers which are $\gamma$-ray-initiated in liquid phase at temperatures near melting point (−35.8°C) and in the solid state differs from that of the polymers radically initiated at −20 to 80°C. The stereoregularity and the conversion suggest the existence of an ionic mechanism in the polymerization at low temperatures. (auth)

**19301** $\gamma$-RADIOLYSIS OF KETONE POLYMERS. III. Copolymers of Ethylene and Carbon Monoxide. Slivinskas, J. A.; Guillet, J. E. (Univ. of Toronto). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 7, 1469-1491(Jul 1974).

The $\gamma$-radiolysis of copolymers of ethylene and carbon monoxide (CO-PE) containing 0−9 wt% of CO has been studied in the solid phase under vacuum with respect to hydrogen production, scission, and crosslinking. In this regard, the introduction of carbonyl groups into polyethylene increased both the scission and crosslinking efficiency. However, a theoretical statistical treatment for random scission and crosslinking, which was used to calculate G(s) and G(x) yields, predicted gelation with irradiation dose; this was confirmed experimentally. The increased G(x) values are attributed to the localization of absorbed energy in the carbonyl group arising from preferential trapping of thermalized secondary electrons. A stoichiometric balance is shown to be consistent with the reduction of one carbonyl group to a secondary alcohol per excess crosslink observed. The $G(H_2)$ yield is reduced by the presence of ketone groups to a level which is in close agreement with the yield obtained for the model ketone 12-tricosanone. This quenching of $H_2$ production is explained by intramolecular electronic energy transfer along the chain to the carbonyl group with concomitant intermolecular charge transfer between neighboring molecules. (auth)

**19302** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. I. Effect of Reaction Conditions on the Polymerization. Senrui, S.; Suwa, T.; Konishi, K.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 1, 83-92(Jan 1974).

The effect of reaction conditions on the rate of $\gamma$-radioinduced emulsion polymerization of ethylene was studied by use of a 500-ml autoclave. Among various kinds of emulsifiers, a series of potassium salts of fatty acids gave high rates of the polymerization. The polymerization was inhibited by the presence of oxygen, but the rate of polymerization followed by the induction period was not influenced by the initial presence of oxygen. Stirring rate and the monomer : water ratio did not affect the rate of polymerization. The rate of polymerization was maximum at about 80°C, and number-average molecular weight was influenced by the temperature in a similar manner as the rate of polymerization. This suggests that the change of mobility of propagating radical in the polymer particle changes the rate of termination reaction. The rate of polymerization was proportional to the 1.7 power of the reaction pressure. (auth)

**19303** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. II. Effect of Potassium Myristate Concentration and Dose Rate on the Rate of Polymerization in Connection with Polymer Properties, Kinetics, and Mechanism. Senru, S.; Suwa, T.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 1, 93-103(Jan 1974).

Gamma-radioinduced emulsion polymerization of ethylene with potassium myristate as an emulsifier was studied in connection with the kinetics and the mechanism. The molecular weight of polymer was relatively low, of the order of $10^3$, when a sufficient amount of emulsifier was used. However, polyethylene gel was produced in the absence of a sufficient amount of emulsifier. The rate of polymerization was proportional to the 0.5 power of dose rate and increased slightly with increasing emulsifier concentration. The rate of seeded polymerization followed a similar trend to that for conventional polymerization. Kinetic analysis of these results suggests that the escape of radicals produced by chain transfer of propagating radical with the emulsifier and the monomer from polymer particles into the aqueous phase plays an important part in the rate of polymerization. The melting temperature and the crystallinity of the polymer significantly decreased with increasing polymerization temperature in the range 40 to 60°C. (auth)

**19304** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. III. Emulsion Polymerization with Ammonium Perfluorooctanoate as the Emulsifier. Senrui, S.; Suwa, T.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 1, 105-120(Jan 1974).

Gamma-radioinduced emulsion polymerization of ethylene with ammonium perfluorooctanoate as an emulsifier was studied in order to elucidate the effect of the number of polymer particles. Owing to the stable structure of the emulsifier from a radical attack, no C−F bond was detected in the polyethylene as expected. The polyethylene produced was mostly gel containing a small amount of low molecular weight polyethylene. This may be attributable to chain transfer to the polyethylene. The effects of dose rate and of concentration of the emulsifier were determined without considering the chain-transfer reaction to the emulsifier. By considering the escape of the radical which is produced by chain transfer to the monomer from the polymer

particle to the aqueous phase at the steady state, the following equation is derived: $\{R_p/I = (K_i K_\beta^2[N_T]/2K_0\alpha R_p) - (K_i K_p/K_0\alpha\}$. The experimental results could be explained by this equation, and the apparent rate constants were obtained. (auth)

**19305** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. IV. Effect of Pressure, Temperature, and Additives on Rate in Connection With Number of Polymer Particles. Senrui, S.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 3, 535-552(Mar 1974).

The effects of pressure, temperature, and additives on the rate of radiation-induced emulsion polymerization of ethylene with FC-143 as emulsifier were studied kinetically. The rate of polymerization was proportional to the 2.5 power of ethylene fugacity, and the apparent rate constant (rate of polymerization/2.5 power of ethylene fugacity) was constant below 78°C. Above this temperature, the rate constant decreased with an apparent activation energy of −8.2 kcal/mole. These facts can be interpreted in connection with the polymer structure and the change of rate of escape of radicals from the polymer particle into the aqueous phase. The rate of polymerization decreased on addition of a series of n-aliphatic alcohols due to the chain-transfer reaction and consequent escape of radicals to the aqueous phase. On the other hand, the addition of tert-butyl alcohol increased the rate of polymerization, probably because of its effect in increasing swelling of the polymer particles. Addition of electrolytes increased the rate of polymerization as a result of the increase of the number of polymer particles. (auth)

**19306** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. V. Copolymerization of Ethylene With Hexafluoropropylene. Senrui, S.; Ito, M.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 3, 627-637(Mar 1974).

The emulsion copolymerization of ethylene with hexafluoropropylene was studied by using $^{60}Co$ γ-radiation as the initiator. The apparent rate of copolymerization is proportional to the 1.6 power of ethylene fugacity. The activation volume was calculated from the pressure dependence of the apparent rate constant of copolymerization and was −30 ml/mole, which is smaller than the value reported by Wada et al. for ethylene polymerization in tert-butyl alcohol. The copolymer produced had a broad composition from ethylene-rich to alternative. As expected, the former was a crystalline, polyethylene-like copolymer, but the latter was an amorphous and rubberlike copolymer. The glass transition temperature of the copolymers increased with an increase in hexafluoropropylene content. The thermal degradation temperature in an atmosphere of nitrogen decreased slightly with introduction of hexafluoropropylene in polyethylene, but the thermal degradation behavior in air was complicated by the introduction of hexafluoropropylene. (auth)

**19307** RADIATION-INDUCED EMULSION POLYMERIZATION OF ETHYLENE. VI. Continuous Flow System. Senrui, S.; Kodama, A.; Takehisa, M. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 10, 2403-2417(Oct 1974).

The radiation-induced emulsion polymerization of ethylene in a continuous flow system was carried out at 100°C by using FC-143 and potassium myristate. The polymer concentration in the latex during the course of the polymerization oscillated several times and then approached a steady-state value in a few hours in the case of short residence time. The rate of polymerization was almost constant within the residence time range of 0.2−0.9 hr. This is explained by the kinetics assuming the same mechanism previously proposed in the batch system that is, the number of polymer particles in this range is considered to be constant. Gel formation was observed at longer reaction times in spite of the continuous supply of myristate micelles, possibly because large polymer particles are produced in this stage. The concentration of carbonyl group in the polymer produced by chain transfer to adsorbed myristate ion changes in the same way as the polymer concentration with reaction time. The methyl group in the polymer is produced mainly by chain transfer to the polymer, and the concentration is nearly constant during the polymerization except in the initial stage. The rate constants for the continuous polymerization were very different from the batch polymerization previously studied, despite their similarities in nature. The mass transfer rate of the emulsifier from the micelles to the polymer particles requires future study. (auth)

**19308** RADIATION-INDUCED EMULSION COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH PROPYLENE. III. Polymerization Mechanism. Suzuki, N.; Matsuda, O.; Okamoto, J. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 9, 2045-2052(Sep 1974).

In the γ-radioinduced emulsion copolymerization of tetrafluoroethylene with propylene, the dose rate dependence, the effect of emulsifier concentration, and the effect of monomer composition were studied. The rate of polymerization was proportional to the 0.90 power of the dose rate and the 0.26 power of the emulsifier concentration. The degree of polymerization was independent of the dose rate and the emulsifier concentration. Both the rate of polymerization and the degree of polymerization increased with tetrafluoroethylene content in the monomer mixture. The resulting copolymer was an alternating polymer over a wide range of monomer composition. It was concluded from the dose rate dependence of the rate of polymerization that the emulsion copolymerization is mainly terminated by degradative chain transfer of the propagating radical to propylene. (auth)

**19309** RADIATION-INDUCED EMULSION COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH PROPYLENE. IV. Effects of Emulsifier Concentration and Dose Rate. Matsuda, O.; Okamoto, J.; Suzuki, N.; Ito, M.; Danno, A. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 9, 1871-1880(Sep 1974).

Gamma radioinduced emulsion copolymerization of tetrafluoroethylene with propylene was carried out by batch operation with an initial molar ratio of tetrafluoroethylene to propylene of 3.0 in the emulsifier concentration range of 0.1 to 3.0% and in the dose rate range of $2 \times 10^4$ to $2 \times 10^5$ R/hr. The effects of emulsifier concentration and dose rate on the polymerization rate and the number-average degree of polymerization are discussed in comparison with the Smith-Ewart theory. The polymerization rate is proportional to the 0.26 power of emulsifier concentration and to the 0.7 power of dose rate. The degree of polymerization is independent of the emulsifier concentration and the dose rate above the the critical micelle concentration (CMC) of the emulsifier. These results are not in agreement with the Smith-Ewart theory. It is explained that the termination reaction is a degradative chain transfer of propagating radicals to propylene. On the other hand, the copolymerization in emulsion occurs either below the CMC or in the absence of emulsifier. Under these conditions, however, it is impossible to obtain a copolymer of high molecular weight at a high rate of polymerization because of the presence of a small number of polymer particles formed and the short interval of chain growth in the polymer particle. (auth)

**19310** ELECTRON SPIN RESONANCE STUDIES ON RADIATION GRAFT COPOLYMERIZATION IN POLYETHYLENE. II. Grafting Initiated by Allyl Radicals Trapped in Irradiated Polyethylene. Seguchi, T.; Tamura, N. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 9, 1953-1964(Sep 1974).

The regions trapping allyl radicals in electron-irradiated polyethylene and the reactivity of the radicals with various monomers were studied by electron spin resonance. Most of the allyl radicals are trapped in defects or surfaces of the crystallite, and only 10% of the radicals are trapped inside the crystallites. Since the reactivity of the allyl radicals depends on whether they come in contact with reactive monomers, the rate of reaction is related to the concentration of the monomers. When grafting reactions are initiated by allyl radicals, the rate of initiation is rapid and the rate of termination at the initial stage is also very fast. Consequently the yield of grafting increases at the initial stage but soon levels off, which is in contrast to the grafting behavior with alkyl radicals. (auth)

**19311** ROLE OF CHAIN TRANSFER IN HETEROGENEOUS POLYMERIZATION OF ETHYLENE. Watanabe, T.; Wada, T.; Takehisa, M.; Machi, S. (Japan Atomic Energy Research Inst., Takasaki). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 9, 2027-2033(Sep 1974).

The role of chain transfer was studied for the γ-radioinduced polymerization of ethylene in precipitating media, namely n-butyl alcohol, tert-butyl alcohol, and their mixtures. The affinities of those solvents for polyethylene are similar, but the chain-transfer coefficient of n-butyl alcohol is larger than that of tert-butyl alcohol. The polymerizations were carried out in a reactor of 100 ml under a pressure of 300 kg/cm², at 60°C, dose rate of $3.07 \times 10^4$–$1.75 \times 10^5$ rad/hr in the presence of 50 ml of solvents. The polymerization in tert-butyl alcohol shows the kinetic behavior characteristic of a heterogeneous polymerization, such as rate acceleration, high dose rate dependence of polymerization rate, and low dose rate dependence of polymer molecular weight, whereas the polymerization in n-butyl alcohol does not exhibit such behavior and gives polymer having a molecular weight much lower than that of polymer obtained in tert-butyl alcohol. The polymer formed in tert-butyl alcohol exhibits a bimodal molecular weight distribution measured by gel permeation chromatography. In mixed tert-butyl alcohol and n-butyl alcohol solvent, with increasing fraction of n-butyl alcohol, the two peaks not

only shift to lower molecular weight but the higher molecular weight peak becomes relatively small. Eventually, the polymer formed in n-butyl alcohol exhibits a unimodal distribution. Those results are well explained on the basis of the proposed scheme for heterogeneous polymerization. (auth)

**19312** CRYOSCOPY OF γ-IRRADIATED ISOTACTIC POLY-(METHYL METHACRYLATE). Kusy, R. P.; Turner, D. T. (Univ. of North Carolina, Chapel Hill). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 9, 2137-2140(Sep 1974).

The depression of the melting temperature of isotactic poly-(methyl methacrylate) (PMMA) was studied to see if it provides an estimate of chemical changes caused by high-energy irradiation. It was found that irradiation of isotactic PMMA results in an approximately linear dependence of the melting temperature on radiation dose. In principle, this allows an estimate of crystalline units damaged by irradiation, but at the present time only a range of values can be obtained because of uncertainty about the heat of fusion. (JGB)

**19313** KINETIC APPROACH TO RADIATION-INDUCED GRAFTING IN THE POLYETHYLENE–STYRENE SYSTEM. Imai, M.; Shimizu, H. (Tokyo Metropolitan Isotope Research Center). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 12, 2729-2739(Dec 1974).

To investigate the mechanism of γ-radioinduced grafting in this system, the increase of monomer concentration in the polyethylene film in styrene vapor was evaluated by measuring the weight increase and formulated to be $V([M_\infty] - [M])$. The decay of radical concentration was also measured by ESR and the rate constant of the decay was determined. The alkyl type radical was affected only a little by styrene, while the allyl type radical was much affected by styrene. A new computer investigation method was proposed to clarify the reaction mechanism. The data obtained were substituted into differential equations and used to calculate the pattern of increase of the degree of grafting for the preirradiation method with reaction in the vapor phase. Results of these calculations suggest that only allyl type radicals induce grafting reactions and that the grafting reaction seldom occurs in the region of grafted polystyrene. (auth)

**19314** STARCH AND AMYLASE DEGRADATION BY $^{60}$Co γ-IRRADIATION. Hofreiter, B. T. (Northern Regional Research Lab., Peoria, IL). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 12, 2755-2766(Dec 1974).

The effects of γ irradiation (0.02 to 4.0 Mrad absorbed dose and 1.2 Mrad/hr dose rate) on depolymerization and selected physical properties of corn starch and amylase (both dry solid and solution forms) were investigated under conditions used to make graft polymers. Radiation introduces an alkali-sensitive structure, most likely β-alkoxycarbonyl, having a G value of 2.8. A dimethyl sulfoxide (DMSO)–acetic acid–water solvent for intrinsic viscosity was developed that degraded irradiated amylase less than did aqueous 90% DMSO. The G (scission) value of 1.3 for solid amylase irradiated at 0°C under nitrogen is lower than most literature values for either amylase or other polysaccharides. The protection of amylase against irradiation degradation in water by additions of DMSO is noteworthy. The G (scission) for amylose irradiated in 99.8% DMSO is 2.3; whereas, in water it is 30. (auth)

**19315** KINETICS OF RADIATION-INDUCED BULK POLYMERIZATION OF VINYL CHLORIDE IN THE TEMPERATURE RANGE OF −50 TO 90°C. Tavan, M.; Palma, G.; Carenza, M.; Brugnaro, S. (CNR, Padua). J. Polymer Sci., Polym. Chem. Ed.; 12: No. 2, 411-432(Feb 1974).

Kinetic investigations on the bulk polymerization of vinyl chloride initiated by exposure to $^{60}$Co γ rays were carried out in the temperature range of −50 to 90°C at dose rates varying from 0.15 to 50 rad/sec. Some polymerization runs were also carried out in a centrifugal field. As generally reported for this polymerization system, in which the polymer is insoluble in the monomer, the polymerization rate was found to change as a function of the amount of the polymer formed in a special fashion. This particular function has been shown to be greatly influenced by the polymerization temperature and to be independent of the rate of initiation, or, more rigorously, of the dose rate. Thus, at any given temperature the equation of the polymerization conversion rate could be written in the form of the product of two separate functions, one for the polymerization conversion and the other for the dose rate. While for the latter the results gave an essentially square-root dependence on dose rate as is normally found for homogeneous polymerization, the former has been discussed in the terms of recently advanced kinetic schemes, based on a two-phase polymerization model. The kinetic parameters found in this work are in agreement with previous authors' data. (auth)

**19316** REACTION KINETIC INVESTIGATIONS IN NEUTRON-IRRADIATED ALKALI HALIDE SINGLE CRYSTALS. Felix, F. W.; Mueller, M. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F. R. Germany). Bereich Kernchemie und Reaktor); Meier, K. (Bundesanstalt fuer Materialpruefung, Berlin (F. R. Germany)). Z. Naturforsch., a; 29: No. 9, 1299-1305(Sep 1974). (In German).

It is often observed that the isothermal degassing of the systems KCl–Ar, CsBr–Xe, and CsI–Xe cannot be described by Fick's law. According to the diffusion model of Hurst and Gaus one can interpret such deviations by assuming a reaction of first order between rare gas atoms and lattice defects. This model explains qualitatively several experimentally observed phenomena very well. A quantitative interpretation of the obtained results, however, leads to contradictions. (auth)

**19317** INVESTIGATIONS ON THE γ-CLEAVAGE OF NUCLEUS-SUBSTITUTED ALKYLBENZOLES INDUCED BY ELECTRON COLLISION BY MEANS OF DEUTERIUM-LABELLED DERIVATIVES. Marten, A. (Bonn Univ. (F. R. Germany). Mathematisch-Naturwissenschaftliche Fakultaet). 19 Apr 1973. 86p. (In German). INIS.

Available from the library of the Bonn Univ.

Meta and para-substituted n-hexylbenzenes and their 1'-dideuterated analogues were synthesized. Mass spectrometric studies showed that substituents that stabilize the radical electron density at the atom C-2 and C-6 of the benzene ring by a pronounced mesomeric effect promote the initial hydrogen transfer from the chain and thus the γ-cleavage. With the help of the 3-iodine product it was shown that the influences by mesomeric effects obviously are not the only determining factor. A qualitative correlation could be found between the substituent constants sigma of the Hammett relation and the relative extent of the fragmentation studied. (GE)

**19318** MECHANICAL PROPERTIES OF ORIENTED POLYMERIC MATERIALS MODIFIED BY THE GRAFT POLYMERIZATION METHOD. Kurilenko, A. I.; Kalinin, V. N. (All-Union Scientific-Research Inst. of Synthetic Rubber, Leningrad). Dokl. Phys. Chem. (Engl. Transl.); 217: No. 1-3, 682-685(Jul 1974).

Translated from Dokl. Akad. Nauk SSSR; 217: No. 3, 618-621 (Jul 1974).

Equations are given for the strength and drawing ratio of a grafted oriented material in terms of contributions from the main and grafted polymers. Experiments were performed with Kapron fibers and with polyethylene films (grafting of polyacrylonitrile). Graft polymerization was initiated by $^{60}$Co γ radiation from acrylonitrile–solvent. Results show that the strength of grafted oriented materials is additively composed of the strengths of the grafted structures and the fibrils of the matrix. (DLC)

**19319** SOLVENT EFFECTS OF BOTH TRANSIENT OPTICAL SPECTRA AND PRODUCTS IN RADIATION-INDUCED POLYMERIZATION AND DIMERIZATION OF VINYLCARBAZOLE. Tagawa, S. (Tokyo Univ.); Tabata, Y.; Arai, S.; Imamura, M. J. Polym. Sci., Polym. Lett. Ed.; 12: No. 10, 545-548(Oct 1974).

The effect of the solvent on the radiation-induced dimerization and polymerization products of vinylcarbazole and their transient optical spectra was studied in aerated and deaerated solutions of benzonitrile, acetone, ethylmethylketone, diethylketone, acetophenone, nitrobenzene, benzene, toluene, and tetralin. In nitrobenzene, benzene, toluene, and tetralin the polymer is produced and the optical spectra are similar to those of the monomer and polymer cations. In the other solvents the cyclodimer is produced with corresponding spectra. (JSR)

**19320** PROMOTERS FOR RADIATION INDUCED CROSS-LINKING IN POLYMER SUBSTANCES. Pearson, D. S.; Shurpik, A. (to The Firestone Tire and Rubber Co.). US Patent 3,843,502. 22 Oct 1974. Filed date 1 Jun 1971. 6p.

A description is given of a process for the production of vulcanizates of diolefin rubbers by electron irradiation of compositions containing such rubbers. Polyhydrosulfides such as 1,10-dimercaptodecane are used as direct promoters. Indirect promoters may also be used to lower the total dose requirements. (Official Gazette)

**19321** RATES OF REACTION OF $O^-$, OH, AND H WITH METHYLATED BENZENES IN AQUEOUS SOLUTION. Optical Spectra of Radicals. Sehested, K. (Danish Atomic Energy Commission, Roskilde); Corfitzen, H.; Christensen, H. C.; Hart, E. J. J. Phys. Chem.; 79: No. 4, 310-315(13 Feb 1975).

Benzyl type radicals are formed by pulse radiolysis in aqueous alkaline solutions by reaction of $O^-$ with methylated benzenes via abstraction of an H atom from a methyl group. The same radicals

are formed in acid solutions but in an indirect way. Water elimination from the OH addition complex involving a proton takes place. Besides adding to the benzene ring the OH radicals also react by direct abstraction of an H atom from a methyl group. The amount of abstraction is directly proportional to the number of methyl groups in the hydrocarbon. H atoms add to methylated benzenes to form cyclohexadienyl radicals. The rate constants for $O^-$, OH, and H reacting with methylbenzenes are of the order $2 \times 10^9$, $7 \times 10^9$, and $3 \times 10^9$ $M^{-1}$ $sec^{-1}$, respectively. The rate for the water elimination reaction varies for the different compounds and the values are listed. Recent experiments indicate that this reaction has an intermediate step with a species absorbing above 400 nm. This species is tentatively assigned as a cation radical. (auth)

**19322** REDOX POTENTIALS OF FREE RADICALS. IV. Superoxide and Hydroperoxy Radicals $\cdot O_2^-$ and $\cdot HO_2$. Rao, P. S.; Hayon, E. (Pioneering Research Lab., Natick, MA). J. Phys. Chem.; 79: No. 4, 397-402(13 Feb 1975).

The fast-reaction technique of pulse radiolysis and kinetic absorption spectrophotometry was used to generate $\cdot O_2^-$ and $\cdot HO_2$ radicals in aqueous solution, and follow their one-electron redox reactions. In the presence of electron acceptors A, the one-electron oxidation of these radicals was monitored by following the formation of $\cdot A^-$ radicals: $\cdot O_2^- \rightleftharpoons O_2 + \cdot A^-$. Similarly, the one-electron reduction of $\cdot O_2^-$ was monitored in the presence of electron donors: $\cdot O_2^- + AH_2 \rightarrow H_2O_2 + \cdot A^-$. The efficiencies of these electron transfer processes were found to be dependent on the two-electron redox potentials of the electron donor or acceptor compounds used. From the midpoint (50% electron transfer) of these titration curves the kinetic potentials of some redox couples could be derived (at pH 7.0, ~25°): $E_k^{01} = +0.07$ V for the $O_2|\cdot O_2^-$ couple and $E_k^{01} \geq +0.36$ V for the $\cdot O_2^-|H_2O_2$ couple. The oxidation of $\cdot O_2^-$ was found to take place under reversible equilibrium conditions, whereas the reduction of $\cdot O_2^-$ was not reversible under the experimental conditions used. The observed rate constants of electron transfer reactions involving $\cdot O_2^-$, $\cdot HO_2$, and $O_2$ with a large number of acceptors and donors have been tabulated and found to be in general agreement with the $E_k^{01}$ values derived for the appropriate redox couples. (auth)

# Radiochemistry and Nuclear Chemistry

*Refer also to abstracts 19287 and 21292.*

## Hot-Atom Chemistry

*Refer also to abstract 19316.*

## Properties of Radioactive Materials

*Refer also to abstracts 19233, 19275, 20113, 20120, 20121, 20133, 20145, 20146, and 20153.*

**19323** (ANL-Trans-969) SELF-DIFFUSION OF PLUTONIUM IN $(UPu)O_{2-x}$: ROLE OF THE OXYGEN POTENTIAL AND PLUTONIUM CONTENT. Schmitz, F.; Marajofsky, A. Jan 1975. Translation of a French paper. (CONF-741030-4; SM-190/22). 16p. Dep. NTIS $4.00.

From symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

Plutonium diffusion was measured in $(U_{1-y}Pu_y)O_{2-x}$ at 1510°C for plutonium contents of y = 0, 0.04, 0.10, 0.15, 0.20, and 0.30. The oxygen potential was set by performing diffusion annealing in a $CO-CO_2$ gas mixture. Three series of experiments corresponding to $CO/CO_2$ ratios of $10^2$, $10^3$, and $10^4$ were performed. The results, which are described by the relation $\lg D = -(15.9 \pm 0.2) + (2.7 \pm 1)(2x/y)$, show that the diffusion coefficient is a function not simply of the deviation from stoichiometry but rather of the ratio x/y, which expresses the probability that plutonium will be in the reduced state. In order to explain the result, the existence of a complex structural defect, characterizing the oxygen deficit region of the mixed oxide, is postulated on the basis of thermodynamic and electrical data. This defect consists of a $Pu_2O_3$ molecule and an oxygen vacancy and is stabilized by a covalent-type bond. For the diffusion, an interstitial [or] annular mechanism is proposed, resulting in a transposition of uranium and plutonium atoms. The mechanism implies that two plutonium atoms always remain in the closest vicinity of an oxygen vacancy and that the migration of uranium takes place in a direction opposite to that of plutonium. (auth)

**19324** (DHEW/FDA-75-8010, pp 190-198) GROWTH AND ITS IMPLICATIONS IN THE NUCLEAR FUEL CYCLE. Smiley, S. H. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The impact of the projected development of nuclear power plants in the USA on the growth of the nuclear fuel cycle industry is discussed. Other topics discussed briefly include the uranium demand and supply projections to the year 2000, safeguards in the transportation of Pu, and the management of radioactive wastes. (CH)

**19325** (INIS-mf-1604) PREPARATION OF CARRIER-FREE RADIOIODATE AND RADIOPERIODATE. Palagyi, S. (Univerzita P. J. Safarika, Kosice (Czechoslovakia). Katedra Vseobecnej Biologie; Univerzita P. J. Safarika, Kosice (Czechoslovakia). Radiobiologicke Lab.). Jun 1973. 23p. (In Slovak). INIS.

2 parts in one volume, each containing various partial reports.

Carrier-free $^{131}IO_3^-$ was prepared from 0.5 ml of $^{131}I^-$ solution adjusted to pH = 3, to which 0.01 ml of a 20% solution of Chloramin B was added. The mixture was stirred for 2 to 3 minutes, 0.01 ml of 98% HCOOH was added, the solution was stirred again, after which a 2.5N NaOH solution was added until pH = 10 was reached. The $^{131}IO_3^-$ solution obtained was stable for 14 days. Carrier-free $^{131}IO_4^-$ was prepared from 0.25 ml of $^{131}I^-$ solution adjusted to pH = 12 to 13 by means of a 2.5N NaOH solution; 0.1 ml of NaClO was added (aqueous solution containing at least 78.7 g/l of active chlorine) and the solution was heated for 30 minutes in water bath. After cooling, 0.05 to 0.1 ml of a 25% $NH_4OH$ solution was added and the mixture stirred again. The solution of $^{131}IO_4^-$ was only stable in the presence of oxidizing agents, the addition of $NH_4OH$ led to a slow reduction of $IO_4^-$ to lower oxidation degrees. Together with the preparation itself, the effects of the type of oxidizing agents, of the composition and of pH of the initial solution, of the temperature, and the time of oxidation were also studied; the results are described in detail. (INIS)

**19326** (INIS-mf-1604) STABILITY IN THE SYSTEM RADIOIODIDE, RADIOIODATE, AND RADIOPERIODATE. (Preliminary Results). Palagyi, S. (Univerzita P. J. Safarika, Kosice (Czechoslovakia). Katedra Vseobecnej Biologie; Universita P. J. Safarika, Kosice (Czechoslovakia). Radiobiologicke Lab.). Jun 1973. 22p. (In Slovak). INIS.

2 parts in one volume, each containing various partial reports.

The stability of radioiodide, radioiodate, and radioperiodate under various conditions was studied in pure solutions and in mixtures. Pure radioiodate solutions were found stable for long time periods at pH between 3 and 11 even when a carrier was added, whereas radioperiodate was only stable at high pH values (12 to 13). Storage of single substances in thin layers resulted in a slow decrease in their radioactivity, especially in the case of radioperiodate. Simultaneously, their composition also varied. Two-component $I^- + IO_3^-$ mixtures were stable at pH = 11, while changes were observed both at lower and higher pH values. Two-component $I^- + IO_4^-$ mixtures changed the composition at pH = 7 and similar changes were also observed in the three-component system. Periodate was the principal unstable component in the above cases. In all cases, $IO_3^-$ prevailed in final solutions, the amount of $I^-$ and $IO_4^-$ decreased; after 8 hours, the amount if $IO_4^-$ was lower than 1% of the initial amount. (INIS)

**19327** STUDIES ON THE RADIOIODINATION OF VERY LOW DENSITY LIPOPROTEIN OBTAINED FROM DIFFERENT MAMMALIAN SPECIES. Fidge, N. H.; Poulis, P. (Australian National Univ., Canberra). Clin. Chim. Acta; 52: No. 1, 15-26(Apr 1974).

Very-low-density lipoprotein (VLDL) isolated from human, pig, and rat serum showed marked differences in labelling patterns when radioiodinated under similar conditions, with greater amounts of $^{125}I$-labelled iodine being incorporated into the lipid moieties of pig and rat VLDL than into human VLDL. The effect on their biological behaviour of introducing increasing amounts of iodine into the lipoproteins was tested for both human and rat VLDL with preparations containing iodine : protein (I/P) ratios varying from 0.5 to 12. The results indicated similarity in the catabolism of rat and human VLDL by the rat, suggesting that this animal is a suitable model for studying VLDL metabolism. (NL)

**19328** URANYL ACETATE AS AN EXCELLENT FIXATIVE FOR LIPOPROTEINS AFTER ELECTROPHORESIS ON AGAROSE GEL. Lozsa, A. (Univ. Medical School, Szeged, Hungary). Clin. Chim. Acta; 53: No. 1, 43-49(May 1974).

The effectiveness of the fixatives most commonly used for lipoproteins after electrophoresis on agarose gel was studied.

The results prove that acetic acid in water or in alcohol does not fix, but allows the removal of the albumin together with the middle part of the alpha lipoprotein band during drying. A double alpha band, therefore, arises artificially. After fixation with methanol or ethanol, not only the alpha, but also the greater part of the beta lipoprotein group remains soluble. Both trichloroacetic acid + formaldehyde, and picric acid, proposed earlier in the literature for the fixation of serum proteins, proved to be effective for lipoproteins, but uranyl acetate was found to be by far the best of all the fixatives yet investigated. (NL)

**19329** REACTION OF THORIUM TETRACHLORIDE WITH ALKALINE EARTH CHLORIDES. Gorbunov, L. V.; Desyatnik, V. N.; Raspopin, S. P.; Trifonov, K. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Neorg. Khim.; 19: No. 11, 3093-3095 (Nov 1974). (In Russian).

By the method of differential thermal analysis studies were carried out on the fusion diagrams in the binary systems $MeCl_2$-$ThCl_4$ (where Me is Mg, Ca, Sr and Ba). It is shown that eutectic melts are formed on reacting thorium tetrachloride with the chlorides of magnesium, calcium and strontium. In the $BaCl_2$-$ThCl_4$ system two incongruently melting compounds $3\ BaCl_2 \cdot ThCl_4$ and $3\ BaCl_2 \cdot 2\ ThCl_4$ were found. (tr-auth)

**19330** PRODUCTION AND PROPERTIES OF THULIUM AND YTTERBIUM PERTECHNETATES. Zaitseva, L. L.; Konarev, M. I.; Velichko, A. V.; Sukhikh, A. I.; Chebotarev, N. T. Zh. Neorg. Khim.; 19: No. 11, 2973-2977(Nov 1974). (In Russian).

By reacting pertechnic acid with thulium and ytterbium oxides the compounds $Tm(TcO_4)_3 \cdot 4H_2O$ and $Yb(TcO_4)_3 \cdot 4H_2O$ were obtained for the first time. By the method of thermal analysis a study was carried out on the mechanism of dehydration of the tetrahydrates of thulium and ytterbium pertechnetates. X-ray analysis and an analysis of infrared spectra showed that the tetrahydrate, dihydrate and the anhydrous pertechnetate of thulium are isostructural with the corresponding compounds of ytterbium pertechnetate. (SJR)

**19331** URANIUM–SULFUR SYSTEM. Ellert, G. V.; Sevast'yanov, V. G.; Slovyanskikh, V. K. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 19: No. 11, 3107-3111 (Nov 1974). (In Russian).

By the methods of differential thermal, x ray, and chemical and microstructural analyses a study was carried out on the high-temperature part of the uranium-sulfur system. Measurements of the microhardness were taken on fused samples. From the data of this study and other literature studies a phase diagram of the system is constructed. (SJR)

**19332** ACTINIDES: ELECTRONIC STRUCTURE AND RELATED PROPERTIES. Volume I. Freeman, A. J.; Darby, J. B. Jr. (eds.). Materials Science and Technology. New York; Academic Press, Inc. (1974). 376p. $36.00.

The book contains six chapters: crystal field theory; electronic energy band structure of the actinide metals; magnetic properties of actinide compounds; NMR and electronic structure of the actinides; hyperfine studies in the actinide series using Moessbauer resonance and angular correlation techniques; and neutron scattering studies of the actinides. The chapters were abstracted and indexed individually. (LK)

*For abstracts of individual chapters see: 19333–19338.*

**19333** CRYSTAL FIELD THEORY. Chan, S. K. (Max-Planck-Institut fuer Biophysikalische Chemie, Gottingen, Ger.); Lam, D. J. pp 1-49 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

The chapter on crystal field theory is primarily concerned with understanding the magnetic properties of actinide compounds and of systems doped with actinide impurities within the framework of the crystal field model. (LK)

**19334** ELECTRONIC ENERGY BAND STRUCTURE OF THE ACTINIDE METALS. Freeman, A. J.; Koelling, D. D. (Northwestern Univ., Evanston, IL). pp 51-108 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

The present state of our understanding of the electronic properties of the actinide metals are derived from the electronic band theory of solids is reviewed. Energy band structure of Ac, Th, U, Np, and Pu metals and electronic band structure of Am, Cm, and Bk are considered. (LK)

**19335** MAGNETIC PROPERTIES OF ACTINIDE COMPOUNDS. Lam, D. J.; Aldred, A. T. (Argonne National Lab., IL). pp 109-179 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

The following data are given for actinide compounds: lattice parameters, magnetism, Curie-Weiss constants, ordering temperature, and ordered moment. Compounds considered are oxides, halides, and other salts; AnX compounds; $An_3X_4$ and $An_2X_3$ compounds; $AnX_2$ compounds, $AnX_3$ compounds; and binary and ternary miscellaneous compounds. (LK)

**19336** NUCLEAR MAGNETIC RESONANCE AND ELECTRONIC STRUCTURE OF THE ACTINIDES. Fradin, F. Y. (Argonne National Lab., IL). pp 181-235 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

NMR work on the actinide metals, NaCl-type compounds, and cubic Laves-phase compounds is reviewed; NMR results in the hydrides and in miscellaneous compounds are surveyed; and a brief survey of experimental EPR results on dilute quantities of actinide ions in insulating crystals is given (LK)

**19337** HYPERFINE STUDIES IN THE ACTINIDE SERIES USING MOESSBAUER RESONANCE AND ANGULAR CORRELATION TECHNIQUES. Dunlap, B. D. (Argonne National Lab., IL); Kalvius, G. M. pp 237-301 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Hyperfine-interaction studies are reviewed, and the solid-state information obtained by such measurements is given. The three techniques considered are: nuclear orientation, perturbed angular correlation, and Moessbauer effect or nuclear $\gamma$ resonance. (LK)

**19338** NEUTRON SCATTERING STUDIES OF THE ACTINIDES. Lander, G. H.; Mueller, M. H. (Argonne National Lab., IL). pp 303-342 of Actinides: Electronic Structure and Related Properties. Vol. I. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

The chapter on neutron scattering studies covers: crystallographic studies, magnetic properties of actinide compounds, the magnetic form factor, and inelastic neutron studies. (LK)

**19339** ACTINIDES: ELECTRONIC STRUCTURE AND RELATED PROPERTIES. Volume II. Freeman, A. J.; Darby, J. B. Jr. (eds.). Materials Science and Technology. New York; Academic Press, Inc. (1974). 397p. $36.50.

Volume II contains eight chapters: Band structure of actinide compounds possessing NaCl-type symmetry; Many electron effects in actinides; Optical properties and electronic structure of the actinides; Crystal chemistry of actinide compounds; Transport properties; Magnetic properties; Ultrasonic waves in actinide metals and compounds; and Surface studies. Individual abstracts were prepared for the chapters. (LK)

*For abstracts of individual chapters see: 19340–19347.*

**19340** BAND STRUCTURE OF ACTINIDE COMPOUNDS POSSESSING NaCl-TYPE SYMMETRY. Davis, H. L. (Oak Ridge National Lab., TN). pp 1-49 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

The underlying purpose of this chapter was to investigate how the present practices used in performing standard electronic band-structure calculations can contribute to the fundamental understanding of the AX compounds' diverse physical properties. The following topics were considered: qualitative expectations of the electronic structure; review of previous calculations; approximations and calculational details; and additional KKR calculations for actinide compounds. (LK)

**19341** MANY ELECTRON EFFECTS IN THE ACTINIDES. Doniach, S. (Stanford Univ., CA). pp 51-72 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Existence of magnetism in the actinide metals; approach to magnetism–the dilute alloy case; local-moment interactions in dilute alloys containing actinide impurities–the effect of spin-orbit coupling; dehybridization in actinide metals and intermetallic compounds; and spin fluctuation scattering at high temperatures–inelastic CPA are considered. (LK)

**19342** OPTICAL PROPERTIES AND ELECTRONIC STRUCTURE OF THE ACTINIDES. Veal, B. W. (Argonne National Lab., IL). pp 73-117 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Theoretical background and experimental considerations of optical absorption, photoemission, and soft x-ray spectroscopy techniques are discussed. Results for metals and compounds and

future directions for studies on elemental actinides, NaCl-type compounds, and Laves phases are given. X-ray photoemission spectra of $UO_2$ and $ThO_2$ are presented. (LK)

**19343** CRYSTAL CHEMISTRY OF ACTINIDE COMPOUNDS. Lam, D. J.; Darby, J. B. Jr.; Nevitt, M. V. (Argonne National Lab., IL). pp 119-184 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

This chapter is devoted to the collection, description, and classification of crystal structure data that have appeared in the literature up to July 1972. The binary intermediate compounds are separated into four categories: actinide-rich phases, phases occurring at or around the equiatomic composition, phases occurring at lower actinide concentration, and phases with dilute quantities of actinide elements. A few ternary compounds are considered. (LK)

**19344** TRANSPORT PROPERTIES. Brodsky, M. B. (Argonne National Lab., IL); Arko, A. J.; Harvey, A. R.; Nellis, W. J. pp 185-264 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Electrical resistivity, magnetoresistance, Hall effect, and thermoelectric power of the pure metals, their alloys, and their compounds which exhibit metallic behavior are discussed. Effects of self-irradiation damage at low temperatures are considered. (LK)

**19345** MAGNETIC PROPERTIES. Nellis, W. J. (Monmouth Coll., IL); Brodsky, M. B. pp 265-288 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Magnetic susceptibility of pure actinides and their alloys (dilute, concentrated, and ordered) is discussed. (LK)

**19346** ULTRASONIC WAVES IN ACTINIDE METALS AND COMPOUNDS. Fisher, E. S. (Argonne National Lab., IL). pp 289-343 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

This chapter constitutes a review of the research, with emphasis on extracting and summarizing the information that has been determined and indicating where ultrasonics can be useful in future research. (LK)

**19347** SURFACE STUDIES. Ellis, W. P. (Los Alamos Scientific Lab., NM). pp 345-367 of Actinides: Electronic Structure and Related Properties. Vol. II. Freeman, A. J. (ed.). New York; Academic Press, Inc. (1974).

Recent experimental approaches in the characterization of surfaces are discussed. Experimental results are given for thorium and uranium. (LK)

**19348** DIRECT RADIOMETRIC STUDY OF ELECTROSORPTION OF TRITIUM LABELED COMPOUNDS. Adsorption of Methanol on Gold Electrodes. Wiechowski, A. (Univ., Warsaw). J. Electrochem. Soc.; 122: No. 2, 252-254(Feb 1975).

A glass scintillation disk was used as the radiation detector, the metallic films being deposited directly on the scintillator surface. Aqueous $Na_2SO_4$ solutions were used as the supporting electrolyte. Results of experiments with $^3H$- and $^{14}C$-labeled $CH_3OH$ indicate use of the tritium labeled compound to be an improvement in the radiotracer method. The main drawback of the tritium radiochemical method is its restriction to interactions of organic species with solid electrodes not involving the C–T breakage. (JGB)

**19349** NEW CHEMICAL PROCEDURE FOR $^{32}P$-LABELING OF RIBONUCLEIC ACIDS AT THEIR 5'-ENDS AFTER ISOLATION. Rapaport, E.; Zamecnik, P. C. (Harvard Univ., Boston). Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 314-317(Jan 1975).

A new technique, which utilizes the chemical reaction between [$^{32}P$]diimidazolidate of orthophosphate and the cetyltrimethylammonium salt of high-molecular-weight RNA in nonaqueous dimethyl formamide, was developed for the $^{32}P$-labeling of RNAs after isolation. The radioactive label of high specific activity is introduced onto a phosphorylated 5'-end of the RNA and renders it suitable for 5'-terminal group analysis. When the labeling reaction was applied to the 70S RNA of avian myeloblastosis virus, a labeled 35S RNA was isolated on sucrose-dimethyl sulfoxide gradients without apparent degradation. (auth)

**19350** HIGH-TEMPERATURE THERMODYNAMIC DATA FOR SOME URANIUM OXIDES WITHIN THE RANGE $UO_{2.25}$–$UO_{2.60}$. Marchidan, D. I.; Tanasescu, S. (Inst. of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 19: No. 9, 1435-1439(Sep 1974).

The two-phase region $U_4O_9 + U_3O_{8-y}$ is investigated. The electromotive force measurements on solid electrolyte galvanic cells have been carried out in order to obtain thermodynamic data for $UO_{2.46}$ and $UO_{2.50}$ uranium oxides. The partial molar free energies, enthalpies and entropies of solution of oxygen in uranium oxides and the corresponding integral quantities as a function of temperature, as well as the equilibrium pressures of oxygen over the oxides have been calculated. (auth)

**19351** PLUTONIUM-DOKUMENTATION. Transplutonium Elemente. Referate Zeitschrift. Dezember 1974. Band 8, Heft 12. 225 Referate (Register Nr. 4047-4484); 83 Referate (Register Nr. 906T-988T). (Plutonium Documentation. Transplutonium Elements. Abstract Journal. December 1974. Volume 8, No. 12. 225 Abstracts (Register No. 4047-4484); 83 Abstracts (Register No. 906T-988T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (Dec 1974). 141p. (In German and English).

This abstract journal is intended to provide continued information on new plutonium literature to scientists and engineers concerned with plutonium and related problems in the fields of chemistry, metallurgy, nuclear physics, reactor physics or nuclear engineering, biology, and medicine. Sources are original publications or important abstract journals, such as "Nuclear Science Abstracts" and "Chemical Abstracts." Abstracts are in English, French, or German. Author, report number, and patent number indexes are provided. (RWR)

**19352** COMPOUNDS OF ZIRCONIUM AND THORIUM WITH NITROGEN AND HYDROGEN. Summary. Blunck, H. (Kiel Univ. (F. R. Germany). Inst. fuer Anorganische Chemie). 10 Feb 1973. 11p. (In German). INIS.

Available from the library of the Kiel Univ.

The preparative and analytical methods and the substance zirconium nitride amide $ZrN(NH_2)$, studies on the system $Th/NH_3$, namely $Th(NH_2)_2$, the disintegration to $Th_2N_2(NH)$, the roentgenography of $Th(NH_2)$, $ThHN_{(1.2)}$, thorium nitride amide $ThN(NH_2)$ and its disintegration product $Th_3N_2(NH)_3$ are explained. (GE)

**19353** URANYL ACETATE AS AN EXCELLENT FIXATIVE FOR LIPOPROTEINS AFTER ELECTROPHORESIS ON AGAROSE GEL. Lozsa, A. (University Medical School, Szeged (Hungary). Institute of Public Health). Clin. Chim. Acta; 53: No. 1, 43-49 (May 1974).

The effectiveness of the fixatives most commonly used for lipoproteins after electrophoresis on agarose gel was studied. The results prove that acetic acid in water or in alcohol does not fix, but allows the removal of the albumin together with the middle part of the alpha lipoprotein band during drying. A double alpha band, therefore, arises artificially. After fixation with methanol or ethanol, not only the alpha, but also the greater part of the beta lipoprotein group remains soluble. Both trichloroacetic acid + formadehyde, and picric acid, proposed earlier in the literature for the fixation of serum proteins, proved to be effective for lipoproteins, but uranyl acetate was found to be by far the best of all the fixatives yet investigated. (INIS)

**19354** THERMOCHEMISTRY OF URANIUM COMPOUNDS. V. Standard Enthalpies of Formation of the Monouranates of Lithium, Potassium, and Rubidium. O'Hare, P. A. C.; Hoekstra, H. R. (Argonne National Lab., IL). J. Chem. Thermodyn.; 6: No. 12, 1161-1169(Dec 1974).

Enthalpies of reaction, $\Delta H_r$, of the monouranates of lithium, potassium, and rubidium with 1 mol $dm^{-3}$ HCl were measured calorimetrically. From these measurements, and auxiliary determinations of the enthalpies of solution in acid of the chlorides of lithium, potassium, and rubidium and of uranyl chloride, the standard enthalpies of formation of the uranates, $\Delta H_f^0$, were derived. The results obtained are as follows: for $\alpha$-$Li_2UO_4$ $\Delta H_r/kcal_{th}$ $mol^{-1}$ is $-(41.77 \pm 0.02)$ and $\Delta H_f^0(c,298.15K)/kcal_{th}$ $mol^{-1}$ $-(463.31 \pm 0.84)$; for $K_2UO_4$ $-(42.07 \pm 0.05)$ and $-(451.39 \pm 0.83)$; and for $Rb_2UO_4$ $-(41.30 \pm 0.05)$ and $-(452.00 \pm 0.85)$. The values of $\Delta H_r$ and $\Delta H_f^0$ differ significantly from those of the only previous study. (auth)

**19355** SYNTHESIS OF $^{14}C$-LABELED DAMMARANE GLYCOSIDE OF GINSENG. Woo, L. K. Yakhak Hoeji; 17: No. 3, 123-128(1973).

Panax A (isopropyl-$^{14}C$) was prepared from natural saponin in good yield by the processes; acetylation, osmium tetroxide oxidation, periodic acid oxidation, wittig process, and saponification. (Korean Sci. Abstr.).

**19356** CALCULATED VS. EXPERIMENTAL HYDROGEN REACTION RATES WITH URANIUM. Condon, J. B. (Union Carbide Corp., Oak Ridge, TN). J. Phys. Chem.; 79: No. 4, 392-397(13 Feb 1975).

Reaction rates for the hydrogen attack on uranium samples were both measured and calculated. The calculations were made using the model involving the diffusion equation and the equation expressing the kinetics of hydriding. All parameters but one were specified by previous experiments. The model was found to be in excellent agreement with reaction rates determined experimentally provided caution was exercised to randomize the grain structure of the starting sample. (auth)

## Radioactive Waste Treatment

*Refer also to abstracts 19279 and 19563.*

**19357** (ANL-8141) FUEL ELEMENT FAILURE PROPAGATION LOOPS: A METHOD FOR HANDLING WASTE SODIUM. Chellew, N. R.; Cafasso, F. A. (Argonne National Lab., Ill. (USA)). Dec 1974. Contract W-31-109-eng-38. 33p. AT.

The contaminant nature of sodium waste produced in Fuel Element Failure Propagation Loop (FEFPL) experiments has been estimated. Options for treatment of the waste in the Hot Fuel Examination Facility/North (HFEF/N) have been examined, and recommendations for handling of the waste are presented. (auth)

**19358** (ARH-ST-105) APPROACH TO THE PREDICTION OF WASTE-FORM STABILITY. Shade, J. W. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Oct 1974. Contract AT(45-1)-2130. 22p. Dep. NTIS $4.00.

Calculated activity diagrams, commonly used to interpret natural groundwater systems, are suggested as an aid in predicting the long-term stability of aluminosilicate types of nuclear waste forms. Possible storage sites can be characterized in terms of mineral-fluid equilibria. Weathering reactions of given waste forms can then be estimated for a particular site. Chemical thermodynamic calculations of hypothetical solubility reactions of crystalline feldspars and glass of the same composition suggest that glass forms are about seven orders of magnitude less stable than crystalline forms in a groundwater environment. (auth)

**19359** (BNWL-B-49) SUMMARY OF RESEARCH ON Tc, Rh, AND Pd BY BATTELLE-NORTHWEST. Roberts, F. P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 11 Jan 1971. Contract AT(45-1)-1830. 7p. Dep. NTIS $4.00.

The research and development performed by Battelle-Northwest on the recovery of technetium, rhodium, and palladium from Hanford wastes are briefly summarized. (LK)

**19360** (BNWL-SA-5214) ROLE OF THE CHEMICAL ENGINEER IN MANAGEMENT OF RADIOACTIVE WASTE. Kreiter, M. R.; Schneider, K. J.; Platt, A. M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1974. Contract AT(45-1)-1830. 20p. (CONF-741205-2). Dep. NTIS $4.00.

From 67th annual meeting of the American Institute of Chemical Engineers; Washington, District of Columbia, USA (1 Dec 1974).

The application of chemical engineering in management of wastes generated in the fuel fabrication, power generation, and spent fuel reprocessing steps of the fuel cycle is discussed. (LK)

**19361** (KFK-2000) DECONTAMINATION SERVICES: ANNUAL REPORT, 1972. Krause, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. (Dekontaminationsbetriebe). Nov. 1974. 140p. (In German). Dep. NTIS (US Sales Only) $10.00.

When the extruder-evaporator was run on trial inactively, a number of bitumen-salt mixtures were prepared in order to investigate their resistance to irradiation and their thermal stability. Research indicated that denitration by formic acid of fission product solutions could be extended into a conditioning procedure. It mainly consists in a partial redissolution of the precipitate formed after complete denitration. In the tests on fixation in glass of highly active fission products the elimination of possible disturbances in the course of glass melting was investigated in the laboratory. The thermite reaction of manganese dioxide and aluminum intended for production of a ceramics containing fission products was investigated in detail. A cleanser was developed for surface contamination, which in addition to good decontamination efficiency, shows little foam formation so that disturbances are reduced in waste water treatment. Within the framework of activities on conventional waste water treatment experiments were carried out which related to the chemical regeneration of active charcoal, the purification through active charcoal of effluent water from cellulose plants, and the conditioning through irradiation of waste water with a view to simultaneous conditioning of glasses containing fission products for ultimate storage. A report is included on work centered around the final storage of radioactive wastes in the Asse salte mine where the storage of medium-active wastes was started. Development of shielded transport containers was continued and also planning for the storage of highly active wastes and for the construction of a prototype cavern system. Operation of the effluent water decontamination facility and the incineration facility is discussed. (JGB)

**19362** NEW DEVELOPMENTS IN THE TREATMENT AND STORAGE OF RADIOACTIVE WASTE PRODUCTS. Boeck, H.; Buchtela, K.; Grass, F. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 359-364(Jun 1974). (In German).

Liquid radioactive waste products will have to be solidified during the eighties at the latest. Current techniques for the solidification of highly active liquid waste are discussed. Separation of isotopes brings advantages not only for the storage but also for the eventual technical application of the longer-life isotopes. The treatment and storage of radioactive gases is discussed. The most important handling procedures are considered and two examples detail the amount of gaseous waste from nuclear installations. (INIS)

**19363** SOLID, RADIOACTIVE WASTE PRODUCTS. Grass, F. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 348-351(Jun 1974). (In German).

After a brief consideration of the production of solid waste products in the nuclear fuel operating cycle, the solid waste products that arise during normal operation of nuclear power stations and that occur in treatment plants are discussed in more detail. The most important technical problems are considered. (INIS)

## Radioisotope Production

*Refer also to abstract 20593.*

**19364** (ORNL-4991) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING JUNE 30, 1974. King, L. J.; Bigelow, J. E.; Collins, E. D. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 31p. Dep. NTIS $4.00.

During the period January 1, 1974, through June 30, 1974, transuranium elements were recovered from 12 irradiated HFIR targets; products recovered are listed in Table 2.1 on p. 2. A campaign to recover americium and curium from accumulated rework materials was also completed. In product finishing operations, 12 g of $^{243}Am$, 117 g of $^{244}Cm$ (160 g of curium), 24 mg of high-purity $^{248}Cm$, 34 mg of $^{249}Bk$, 8 mg of $^{249}Cf$, 207 mg of $^{252}Cf$, 914 $\mu$g of $^{253}Es$ (mixed isotopes), 58 $\mu$g of high-purity $^{253}Es$, and an estimated 0.5 pg of $^{257}Fm$ were processed. Twenty-five HFIR targets, each containing 7 to 9 g of actinides (predominantly curium), were fabricated. There have been no changes in the chemical processing flowsheets normally used at TRU during this report period. In maintenance operations, two tubing bundles that connect processing equipment in Cubicle 4 to tanks in the tank pits and three equipment racks in the cubicles were replaced. Five neutron sources were fabricated, bringing the total fabricated to 74; four sources that had been used in various projects were returned to TRU for reassignment or reprocessing. In special projects, we (1) fabricated two fission chambers containing $^{252}Cf$, (2) fabricated, irradiated, and analyzed the results from a special HFIR target to confirm calculations made for the purpose of optimizing the irradiation of $^{252}Cf$ to produce $^{253}Es$, and (3) prepared two samples of $^{250}Cf$ by irradiation of $^{249}Bk$ in HFIR rabbits. The values currently being used for transuranium element decay data and for cross-section data in planning irradiation-processing cycles, calculating production forecasts, and assaying products are tabulated in the Appendix. (auth)

**19365** METHOD FOR OBTAINING SEPARATED SHORT-LIVED ISOTOPES OF RARE EARTH ELEMENTS. Latuszynski, A. (Joint Inst. of Nuclear Research, Dubna, USSR); Zuk, W.; Zuber, K.; Zuber, J.; Potempa, A. Nukleonika; 19: No. 12, 1043-1056 (1974). (In Russian).

Method of fast extraction of isobars of rare-earth elements by direct separation from the proton irradiated targets without chemical processing has been developed. The efficiency of the diffusion process of separate rare-earth elements from a tantalum target depending on temperature and duration of the process has been measured. The conditions securing a high degree of diffusion during the two to three minute period have been found and the possibility of utilization of the diffusion process for the electromagnetic separation of rare-earth elements according to isobars has been proved. The efficiency of the process of separation using the ion sources with the surface ionization has been measured under different conditions of work. Using the method proposed for investigations in the field of nuclear spectroscopy

the gamma-spectra of short-living isotopes with $T_{\frac{1}{2}} \geq 1$ minute have been measured. The new isotopes $^{161}$Yb (4.2 min), $^{168}$Dy (3.5 min) and $^{132}$Pr (1.6 min) have been identified. The possibility of effective application of this method to spectroscopic investigations of many elements has been proved. (auth)

**19366** PRODUCTION AND CHARACTERISTICS OF $^{125}$Xe: A NEW NOBLE GAS FOR IN VIVO STUDIES. Hines, H. H. Jr.; Peek, N. F.; DeNardo, G. L.; Jansholt, A. L. (Univ. of California, Davis). J. Nucl. Med.; 16: No. 2, 143-147(Feb 1975).

Radionuclides of the noble gases are extensively used to assess ventilation and blood flow in clinical and investigative studies. Xenon-133 is most commonly used but is not optimal for these in vivo studies. Xenon-125 has better physical characteristics and can be produced with a cyclotron by a $^{127}$I(p,3n)$^{125}$Xe reaction; this reaction results in a maximum of 25 mCi/gm/cm$^2$/$\mu$A-hr for 31-MeV protons. Under actual production conditions, 11 mCi/$\mu$A-hr were collected. Xenon-125 decays by electron capture with a 17.2-hr half-life and contributes less radiation per dose of radioactivity than $^{133}$Xe. The radiation dose to the lungs from $^{133}$Xe and $^{125}$Xe is 5.0 and 1.8 mrads/mCi-min, respectively. The radiation dose per usable photon for $^{125}$Xe is only 0.3 of $^{133}$Xe. The principal photons of $^{125}$Xe, 188 keV (55%) and 243 keV (29%), are more intense and are in an energy range that is more advantageous for imaging than the 81 keV (35%) of $^{133}$Xe. These physical properties of $^{125}$Xe result in better spatial resolution at the same information density and with less radioactivity administered to the patient. Phantom studies showed that 12.7-, 9.5-, and 6.4-mm lead bars were resolved with $^{125}$Xe using a 410-keV diverging collimator whereas only the 12.7- and 9.5-mm lead bars were resolved using $^{133}$Xe and either a 410-keV or 140-keV diverging collimator. (auth)

## *Reactor Fuel Reprocessing*

*Refer also to abstracts 19189, 19243, 19532, 19572, 20323, and 21841.*

**19367** (BARC-736) PROCESS CHEMISTRY OF NEPTUNIUM. Part II. Srinivasan, N.; Ramaniah, M. V.; Patil, S. K.; Ramakrishna, V. S.; Swarup, R.; Chadha, A.; Avadhany, G. V. N. (Bhabha Atomic Research Centre, Bombay (India)). 1974. 74p. Dep. NTIS (US Sales Only) $6.75.

The oxidation state analysis of neptunium in the aqueous feed solution from the Plutonium Plant at Trombay was carried out and it was found that neptunium existed mainly as Np(V) in the feed solution. Batch extraction data for Np(IV) and Np(VI) into 30% TBP/Shell Sol T at different aqueous nitric acid concentration and uranium saturation of the organic phase were obtained at 45°C and 60°C and the results are summarized. The distribution coefficients of Np(IV) and Np(VI) were obtained as a function of TBP concentration and the data are reported. The effect of nitrous acid on the extraction of neptunium, present in the aqueous phase as Np(IV) and Np(V), by 30% TBP was studied and the data obtained are given. The data on the rate of reduction of Np(VI) and Np(V) to Np(IV) by U(IV) were obtained for different U(IV) and nitric acid concentrations. Some redox reactions involving Np(IV), Pu(IV), and V(V) were investigated and their possible application in the Purex Process for neptunium recovery were explored. (auth)

**19368** (HW-55223) INVESTIGATION REPORT: PUREX PLANT SILVER REACTOR INCIDENT. Schroeder, O. C. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 27 Feb 1958. 22p. Dep. NTIS $4.25. Declassified 1 Nov 1971.

Circumstances surrounding damage of the silver reactor section of the Cell A dissolver operation in the Purex Plant are reviewed. The silver reactor and its process chemistry, as well as its flushing chemistry, are described. The cause of the incident has not been determined, but it is concluded that it is possibly related to a one-time flushing of the unit with ammonium hydroxide-water. Unstable products formed from reaction of ammonia with silver salts could have been the cause of the uncontrolled chemical reaction occurring in the bottom portion of the silver reactor. Recommendations for future operation and flushing of the silver reactor are made. (JGB)

**19369** (ORNL-TM-4596) SYSTEM FEATURES AND COMPONENT DESCRIPTIONS FOR THE UNIT OPERATIONS OFF-GAS DECONTAMINATION FACILITY. Glass, R. W.; Cochran, H. D. Jr.; Levins, D. M.; Snider, J. W.; Watkin, D. C.; Woods, W. M.; Whatley, M. E. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 144p. Dep. NTIS $7.60.

In a joint development program between Oak Ridge National Laboratory and the Oak Ridge Gaseous Diffusion Plant, the Unit Operations (UNOP) Off-Gas Decontamination Facility and the ORGDP LMFBR-HTGR Fuel Reprocessing Off-Gas Decontamination Pilot Plant will be used to develop and demonstrate (1) a fluorocarbon process for removing krypton from the off-gas of an LMFBR fuel reprocessing plant, and (2) a liquid carbon dioxide process for removing krypton from the off-gas of an HTGR fuel reprocessing plant. The ORGDP Pilot Plant provides a complete processing train for demonstration-type studies of each process, while the UNOP Facility permits a closer study of individual operations of the processes, such as absorption, fractionation, and stripping. The UNOP Facility consists of two packed columns for gas-liquid contacting and associated support items, including gas compressors, solvent pumps, condensers, heaters, and complete sampling and monitoring capabilities. Process cooling is achieved by means of two conventional evaporative-type refrigeration units. Design and operational considerations for the UNOP Facility are presented, and plant safety and operational hazards are discussed. (auth)

**19370** STATE AND PROSPECTS OF REPROCESSING NUCLEAR FUELS, IN RESPECT OF ECONOMIC ELECTRICITY GENERATION AND RELIABLE WASTE HANDLING. Couture, J. (CEA, 75 - Paris (France). Direction des Productions); Hughes, T. G. (British Nuclear Fuels Ltd., Windscale); Zuehlke, P. (United Reprocessors G.m.b.H., Karlsruhe (F. R. Germany)). Brennst.-Waerme-Kraft; 26: No. 9, 403-405(Sep 1974). (In German).

The reprocessing of irradiated nuclear fuels has its special significance in the recovery of fissionable materials that can be used again, and in the reliable handling of radioactive waste. The processes developed in the last 25 years are described, the lines of further development are shown, and the most important economic aspects that have to be taken into consideration in development of a reliable reprocessing industry are considered. (auth)

**19371** DISMANTLING AN ALPHA-CONTAMINATED FACILITY. Harper, R. M. (Du Ponte de Nemours (E. I.) and Co., Aiken, SC). Health Phys.; 27: No. 5, 429-432(Nov 1974).

The difficult task of removing large pieces of highly contaminated equipment from an obsolete $^{239}$Pu facility was completed in a seven-month operation that included structural alteration of the process building. Detailed job planning, job execution, and contamination control were major factors in accomplishing the task. (auth)

# CONTROLLED THERMONUCLEAR RESEARCH

**19372** DESIGN OF A PULSED DEUTERIUM LITHIUM NUCLEAR REACTOR. Fischer, A. G. (Dortmund Univ. (F. R. Germany). Abt. Elektrotechnik). Atomkernenergie; 23: No. 1, 66-68(1974).

1 fig.; 17 refs.

A proposal is presented for a reactor that burns LiD to helium in successive microexplosions which are ignited electrically, and that converts the reaction heat into useful electrical power. Construction details, and a simple test of the principle which could be carried out immediately, are described. (GE)

## Plasma Confinement and Heating

**19373** (CEA-CONF-2742) REVIEW OF THE ELECTROSTATIC AND ELECTROMAGNETIC CONFINEMENT EXPERIMENTS MADE AT THE FRENCH A. E. C. Consoli, T. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de la Physique du Plasma et de la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1973. 40p. (CONF-740316-7). Dep. NTIS (US Sales Only) $5.00.

From conference on electrostatic and electromagnetic confinement of plasmas and the phenomenology of relativistic electron beams; New York, New York, USA (4 Mar 1974).

This review covers work done at the laboratory during the period 1957 through 1974. Experiments are outlined on the electrostatic and electromagnetic plasma confinement and on the plasma acceleration effects due to the combination of an electromagnetic field with a static magnetic field. (MOW)

**19374** PLASMA BOTTLE WITH MULTIPOLAR MAGNETIC CONFINEMENT. Ghielmetti, A.; Balsiger, H.; Eberhardt, P.; Geiss, J.; Hirt, P.; Young, D. (Univ., Bern). Helv. Phys. Acta; 47: No. 4, 473-477(1974). (In German).

A magnetic bottle characterized by the magnetic attachment of Ferroxdure magnetics to the bottle is described. The characteristics of the plasma obtained in this type bottle are outlined. Densities of $10^9$ ions/cm$^3$ can be obtained with a relatively low power consumption. (JSR)

**19375** EXTERNAL RING SYSTEM FOR MAGNETIC PLASMA CONFINEMENT. Lehnert, B. (Kungliga Tekniska Hoegskolan, Stockholm). Phys. Scr.; 10: No. 3, 139-141(Sep 1974).

A new scheme for steady-state magnetic plasma confinement is suggested, consisting of a superposition of two poloidal magnetic field components. The first arises from the unidirectional currents flowing in a number of ring-shaped external conductors. The second is produced by an oppositely directed azimuthal current in the plasma. Whenever necessary, an additional toroidal magnetic field component can be introduced. The scheme differs from those having passive guard conductors surrounding the plasma, in the sense that given currents are fed into the rings from external sources. This scheme provides a closed axisymmetric magnetic bottle, with closed guiding-center drift orbits of the plasma particles, as well as possibilities of "bootstrap" operation. The problems are considered of stabilizing electrostatic modes by means of minimum-average-B geometry, and of stabilizing electromagnetic modes by means of the mutual forces between the currents in the plasma and those in the external conductors. (auth)

**19376** ANOMALOUS ABSORPTION OF ELECTROMAGNETIC ENERGY THROUGH PARAMETRICALLY INDUCED LOWER-HYBRID TURBULENCE. Rogister, A. (Institut für Plasmaphysik der Kernforschungsanlage, Association EURATOM-Kernforschungsanlage, 517 Jülich, Federal Republic of Germany). Phys. Rev. Lett. 34: No. 2, 80-83 (13 Jan 1975).

The nonlinear fate of lower-hybrid electrostatic turbulence triggered by a whistler "pump" wave is discussed. Rapid anomalous absorption of the electromagnetic energy and good ion and electron heating are obtained for very reasonable amplitudes of the pump wave. (auth)

**19377** ADIABATIC COMPRESSION OF PLASMA VORTEX STRUCTURES. Wells, D.R.; Nolting, E.; Cooke, F. Jr.; Tunstall, J.; Jindra, P.; Hirschberg, J. (Department of Physics, University of Miami, Coral Gables, Florida 33124). Phys. Rev. Lett. 33: No. 20, 1203-1206 (11 Nov 1974).

Plasma vortex structures generated by conical theta-pinch guns have been successfully compressed and amplified by secondary adiabatic compression. A pair of vortex rings meet at the center of a primary magnetic mirror. A secondary mirror starts to compress them as soon as the collision has occurred. Peak ion temperatures of 170 eV have been obtained at an $n\tau$ of $10^{12}$ sec/cm$^3$ by utilizing a capacitor bank that stores 250 kJ. (auth)

**19378** INFLUENCE OF INTENSE AC ELECTRIC FIELDS ON THE ELECTRON-ION COLLISION RATE IN A PLASMA. Brownell, J.H.; Dreicer, H.; Ellis, R.F.; Ingraham, J.C. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. Lett. 33: No. 20, 1210-1213 (11 Nov 1974).

The classical electron-ion collision rate, $\nu_{ei}$, has been deduced in the absence of Ohmic heating from the inverse bremsstrahlung absorption rate measured on a laboratory plasma subjected to an intense microwave electric field E whose frequency $\omega$ is near the electron plasma frequency $\omega_p$. The observations, carried out in the transition range, where $eE/(m\omega) \simeq (kT_e/m)^{1/2}$, yield a simple empirical relation that describes the decrease of $\nu_{ei}$ with increasing E. (auth)

**19379** PRESSURE LIMIT OF TOKAMAK PLASMA. Shafranov, V. D. (Inst. of Atomic Energy, Moscow). pp 249-257 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl. 74); CONF-740131-.

A brief review of the principal limitations on the relation of the plasma pressure to the pressure of the magnetic field in Tokamaks imposed by the equilibrium and MHD stability conditions is presented. (auth)

**19380** TRANSIT TIME MAGNETIC PUMPING APPLIED TO AN IGNITION DEVICE: TECHNOLOGICAL ASPECTS. Le Gardeur, R. (CEN, Grenoble, France). pp 431-438 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The practical application of transit time magnetic pumping to a toroidal plasma is described and expressions permitting the determination of the pumping frequency and amplitude are given. The basic physics concerning, first, the difficulty of a hf magnetic field penetrating into a hollow metal cylinder (liner), and, second, the reduction in the eddy current losses of a metal band immersed in a hf magnetic field as its thickness diminishes, are given. Two squirrel-cage type liners, permitting penetration and assuring the necessary electrostatic field shielding, are presented. (auth)

**19381** NUMERICAL SIMULATION OF LOWER HYBRID RESONANCE HEATING. Emery, M. H. Iowa City, IA; Univ. of Iowa (1974). 186p. University Microfilms Order No. 75-1195. Thesis (Ph. D.).

The response of a magnetized plasma to excitation by an external longitudinal electric field oscillating at the lower hybrid frequency is examined by numerical simulation. A two-dimensional, electrostatic, finite-size particle code is used with the ion motion described by standard particle-in-cell methods and the electrons simulated in the guiding-center approximation. The guiding-center model removes the electron mass from consideration and all time scales are measured in units of the inverse ion plasma frequency. An examination of the parameters that control the ion heating lead to the following conclusions: (1) the heating mechanism is not a collisional process, (2) the ion heating rate reaches a maximum for $\lambda \equiv k_\parallel^2 \rho_{el}^2 \simeq 1$, (3) the heating rate and final temperature is improved for frequencies slightly greater than the lower hybrid frequency, (4) the ion heating is improved for low densities ($\omega_{cl}/\omega_{pl} > 1$), and (5) satellite modes appear on both sides of the dominant mode in the frequency spectrum. These results agree with the experimental results of Raimbault and Shohet (1974) and are consistent with linear mode conversion. An analytical analysis of the system shows that the applied field excites a normal mode of the system. This normal mode has a frequency close to the lower hybrid frequency. The amplitude of these density fluctuations increases, resulting in an increase in the ion kinetic energy. The electrostatic potential of the excited mode becomes large enough to weakly trap the ions, heating them further until the nonlinearities of the system become dominant enough to prohibit this mode from absorbing more energy from the applied field. The excited mode saturates and begins to couple to other modes of the system, resulting in a decrease in the ion heating rate. (Diss. Abstr. Int., B)

## Plasma Diagnostics

**19382** (FUPH-R-107) USE OF MAGNETOACOUSTIC OSCILLATIONS AS A PLASMA DIAGNOSTIC TECHNIQUE. Frommelt, J. J. B.; Jones, I. R. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1974. 35p. Dep. NTIS (US Sales Only) $4.75.

A theoretical and experimental investigation of the radial magnetoacoustic oscillations of a cylindrical, magnetized, argon afterglow plasma, is presented. A description is given of a diagnostic technique which allows one to estimate the various interparticle collision frequencies of a plasma from a study of its radial magnetoacoustic oscillations. The reliability of the technique is demonstrated by its ability to predict values for $T_e$ and $Q_D$ which compare favorably with results of previous workers. (AT)

**19383** MORE IMPORTANT METHODS OF PLASMA DIAGNOSTICS. Bito, J.; Bolla, I.; Antal, K. Musz. Tud.; 48: No. 3-4, 303-345(21 Jan 1974). (In Hungarian).

A review is given on passive plasma diagnostics, i.e., the coordinated system of methods for investigating the corpuscular and the electromagnetic radiations of the plasma. Starting with the methods for passive corpuscular plasma diagnostics, the methods for investigating the variation in time and space of the energy flow, the flow of neutral and of loaded particles, also including experimental aspects, are presented. The electromagnetic radiation emitted by the plasma is investigated, including the experimental problems of separating the corpuscular energy flow and a brief theoretical review of plasma spectroscopy is given, which has a widespread methodological literature. (auth)

**19384** SPHERICAL ELECTRIC PROBE IN A CONTINUUM GAS. de Boer, P. C. T.; Ludford, G. S. S. (Cornell Univ., Ithaca, NY). Plasma Phys.; 17: No. 1, 29-43(Jan 1975).

The problem of a spherical electric probe in a continuum gas without chemical reactions is re-examined when the dimensionless probe potential $\omega_p$ is large and comparable to $\rho_p$, the ratio of probe radius to the ion Debye length. An asymptotic scheme for $\omega_p \to \infty$ shows that the ion-sheath region must be carefully matched to them. The properties of the transition equation are investigated in some detail, and numerical results are obtained determining the second-order (ion) current to the probe. Universal curves are given for the first- and second-order currents when the electron temperature equals the ion temperature. The range of validity of the theory is $\omega_p^{-1} \ll \rho_p \ll \omega_p^3$. (auth)

**19385** INTERFEROMETRIC MEASUREMENT OF PARTICLE DENSITIES IN CASCADED ARCS AT ATMOSPHERIC PRESSURE. Baum, D.; Hackmann, J.; Uhlenbusch, J. (Univ., Duesseldorf). Plasma Phys.; 17: No. 1, 79-87(Jan 1975).

Two wavelength interferometry is applied to a cascaded arc burning in Ar, Xe, and He at atmospheric pressure. The interferometer is of the Mach–Zehnder type with a He–Ne laser as a light source. The refractive index of the plasma is measured at the wavelengths $\lambda_1 = 6328$ Å and $\lambda_2 = 33912$ Å and is compared to calculated data. A contribution of excited levels to the refractive index was not found in the temperature and pressure range studied here. Using experimentally determined refractive index profiles neutral and electron density distributions are derived and compared to spectroscopically measured values. The comparison shows that the diagnostic method applied here leads to accurate particle densities without using any assumption concerning the thermodynamic equilibrium state of the plasma. (auth)

**19386** SECOND ORDER FULL COULOMB RELAXATION THEORY OF SPECTRAL LINE BROADENING IN PLASMAS. Whalen, J. E.; Hooper, C. F. Jr. (Operations Research, Inc., Silver Spring, MD). J. Quant. Spectrosc. Radiative Transfer; 14: No. 12, 1337-1344(Dec 1974).

A second-order, quantum-mechanical relaxation theory of spectral line broadening in plasmas that uses a full Coulomb potential to describe the radiator-perturbing electron interactions is presented. A Fourier representation of the interaction is used rather than a multipole expansion. The results for the Lyman-alpha transition in hydrogen are compared with experimental data and with a corresponding relaxation theory computation that uses a dipole approximation. (auth)

## Plasma Kinetics (General)

**19387** NEUTRAL CURRENT LAYERS IN LABORATORY AND COSMIC PLASMAS. Syrovatskii, S. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 74: 3-13(1974). (In Russian).

Consideration is given to the occurrence of a neutral current layer in a plasma having a strong magnetic field, containing a zero line. A discussion is presented on the properties of this layer and its stability. 52 references. (SJR)

**19388** TWO FORMS OF LOW PRESSURE PLASMA IN OXYGEN. Kocian, P. (Lab. of Applied Physics, Lausanne, Switzerland). Helv. Phys. Acta; 47: No. 4, 469-473(1974). (In German).

The electron temperature, energy distribution of the electrons, and the electric field strength were studied in two forms of low-pressure plasma in oxygen. These forms differ from each other by a varying concentration of electrons and negative ions. From 19 reactions which occur in oxygen plasma, 3 are decisive. The rate constants of these processes were discussed as a function of E/p. (tr-auth)

**19389** GIGAWATT MICROWAVE EMISSION FROM AN INTENSE RELATIVISTIC ELECTRON BEAM. Granatstein, V. L. (Naval Research Lab., Washington, DC); Herndon, M.; Sprangle, P.; Carmel, Y.; Nation, J. A. Plasma Phys.; 17: No. 1, 23-28 (Jan 1975).

Microwave generation experiments were carried out on a multi-megavolt electron accelerator (3.3 MV, 80 kA). X-band microwave power as high as 1 GW was measured. Results are compared with a nonlinear theory of unstable resonant interaction between a TE waveguide mode of the electron drift tube and an electron cyclotron wave on the beam. (auth)

**19390** RADIATION DOSAGE ASSOCIATED WITH BALL LIGHTNING. Fleming, S. J.; Aitken, M. J. (Oxford Univ.). Nature (London); 252: No. 5480, 220-221(15 Nov 1974).

Reference is made to a ball lightning event that occurred in England in May 1970, and subsequent investigations using thermoluminescence methods are described. It was concluded that if a radiation dose was associated with the event it would appear to have been less than 5 R. (UK)

**19391** DETERMINATION OF RELATIVISTIC ELECTRON RING MICROSTATE FROM THE SYNCHROTRON RADIATION SPECTRUM. Mahajan, S. M.; Oberman, C. R.; Davidson, R. C. (Princeton Univ., NJ). Plasma Phys.; 16: No. 12, 1147-1153(Dec 1974).

It is shown that a knowledge of the synchrotron emission spectrum for a thin ring of relativistic electrons is sufficient information to reconstruct the microscopic distribution function that self-consistently generates the ring equilibrium. (auth)

**19392** SWEDISH FUSION RESEARCH PROGRAMME. Lehnert, B. (Royal Inst. of Tech., Stockholm). pp 261-264 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The present fusion research program, mainly in the Division of Plasma Physics and Fusion Research, of the Royal Institute of Technology, Stockholm, is briefly outlined. (auth)

## Plasma Kinetics (Experimental)

**19393** TRANSIENT FLOW AND EXPANSION OF A PINCH DISCHARGE PLASMA IN SELF-INDUCED MAGNETIC FIELDS. McKenna, K. F.; York, T. M. (Pennsylvania State Univ., University Park). Plasma Phys.; 17: No. 1, 1-14(Jan 1975).

The formation of a dense argon plasma column in a linear Z-pinch and the ejection of the plasma through an axial orifice electrode are investigated photographically, and with electric, magnetic, and piezoelectric pressure probes. The plasma–magnetic field interaction and gasdynamic flow transients in the exhaust are also studied. Pronounced orifice electrode polarity effects on the plasma acceleration and ejection mechanisms are observed. It is found that the distribution and dynamics of the ejected plasma cannot be established from luminosity profiles. The development of plane blast waves in the far field flow is identified. (auth)

**19394** EXPERIMENTAL STUDIES OF THE CONDITIONS OF OCCURRENCE, AND OF A NUMBER OF CHARACTERISTICS OF A NEUTRAL CURRENT LAYER IN A PLASMA. Frank, A. G. Tr. Fiz. Inst., Akad. Nauk SSSR; 74: 108-166(1974). (In Russian).

Experimental studies were carried out on the conditions of formation of a neutral current layer in the vicinity of the zero line of a magnetic field. It is shown that the anomalous plasma resistance which arises because of the development of small-

scale instabilities hinders the formation of a neutral layer. However, the turbulent conductivity can be increased by increasing the plasma density. A description is given of a method of creating a dense plasma in a quadrupole field. A neutral current layer is developed in a plasma, when its conductivity attains a value of $\sim 10^{14}$ CGSE. A neutral layer is obtained whose width exceeds its thickness by a factor of 5. The magnetic field at the boundary of the layer is increased by a factor of 6 in comparison with the initial value of the field, that is, a high concentration of magnetic energy is attained in the current layer. 108 refs. (SJR)

**19395** INVESTIGATION OF THE ENERGY EXCHANGE MECHANISMS INVOLVING THE $2^3S$ METASTABLE LEVEL IN AN RF HELIUM PLASMA. Swallom, D. W.; Scholz, P. D. (Univ. of Iowa, Iowa City). J. Quant. Spectrosc. Radiative Transfer; 14: No. 12, 1185-1193(Dec 1974).

The energy exchange mechanisms present in a pure helium and a helium–neon plasma were investigated using spectroscopic diagnostic techniques. The plasma was spatially resolved and only the volume element at the plasma centerline was considered in the energy-exchange analysis. The experiment was conducted with a constant total pressure of 0.7 torr, a fixed oscillator frequency of 4 MHz, and a constant input power of 1.8 kW. Emission line spectroscopy was used to determine the population densities of 16 levels in the $n^3S$, $n^3P$, and $n^3D$ series. Spatially resolved, self-absorption measurements of the $2^3P$–$2^3S$ transition were used to determine the $2^3S$ metastable level number density. The electron number density of $3.3 \times 10^{13} cm^{-3}$ was determined from the spatially resolved $H_\beta$ blue wing profile, and a lower bound excitation temperature of 8800°K was determined from a Boltzmann plot of the spatially resolved lower bound levels of the excited helium. The addition of 10% and 20% by volume of neon gas caused a measurable decrease in the population densities of the lower bound levels of helium, while the electron number density and lower bound excitation temperature remained unchanged. Three energy models (local thermal equilibrium, corona, and collisional-radiative) were examined, and the collisional-radiative model was found to best describe the excitation processes for the $2^3S$ level. This model was also appropriate for describing the helium-neon plasma at this level. (auth)

## Plasma Kinetics (Theoretical)

**19396** WHEN IS QUASI-LINEAR THEORY EXACT? Jones, F. C.; Birmingham, T. J. (National Aeronautics and Space Administration, Greenbelt, MD). Plasma Phys.; 17: No. 1, 15-22(Jan 1975).

The cumulant expansion technique of Kubo is used to derive an integro-differential equation for (f), the average one particle distribution function for particles being accelerated by electric and magnetic fluctuations of a general nature. For a very restricted class of fluctuations, the (f) equation degenerates exactly to a differential equation of Fokker-Planck type. Quasi-linear theory, including the adiabatic assumption, is an exact theory only for this limited class of fluctuations. (auth)

**19397** ALGORITHMS FOR THE CALCULATION OF THE POPULATION DISTRIBUTION OF SPECIES AMONG ENERGY LEVELS IN OPTICALLY-THIN SYSTEMS. Myers, B. F. (Science Applications, Inc., La Jolla, CA). J. Quant. Spectrosc. Radiative Transfer; 14: No. 12, 1329-1335(Dec 1974).

A model is presented which is suitable for rapid calculation of the population distribution among energy levels in systems which undergo collisional and radiative processes. To facilitate these calculations, algorithms have been derived which can be used over a wide range of conditions. (auth)

**19398** NUMERICAL INTEGRATION OF MAGNETIC HYDRODYNAMIC EQUATIONS FOR THE VICINITY OF THE ZERO LINE OF THE MAGNETIC FIELD. Gerlakh, N. I.; Syrovatskii, S. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 74: 73-87(1974). (In Russian).

Magnetohydrodynamic equations are integrated numerically with the finite conductivity being taken into account for a homogeneous plasma initially at rest in a hyperbolic magnetic field near the zero line. As a limiting condition a solution of the linearized equations is used far from the zero line in the form of a convergent cylindrical wave of a perturbation in potential which arises in turning on a constant, external electric field directed along the zero line. It is shown that on approaching the zero line the wave becomes nonlinear and leads to the occurrence of a thin current layer. There are no indications of the appearance of a system of slow shock waves corresponding to the model of Petchek. Within the boundaries of the current layer the plasma density increases as compared with the initial density, and decreases in the region close to the current layer. The plasma streams out along the current layer with a velocity close to Alfven. On the edges of the current layer there are regions of reverse current flow. 14 refs. (SJR)

**19399** DYNAMICS OF THE SCREW PINCH. Goedbloed, J. P. (New York Univ.); Zwart, J. W. A. Plasma Phys.; 17: No. 1, 45-67(Jan 1975).

The coupling of the external circuits to the inward motion of a plasma in a screw pinch is considered by solving a set of nonlinear partial differential equations for the plasma simultaneously with a set of nonlinear ordinary differential equations for the circuits. The motion of the plasma couples the $\theta$-circuit to the z-circuit, so that the simple correspondence between $\theta$-circuit and $B_z$ and between z-circuit and $B_\theta$ is lost. As a consequence, the plasma is seen by the circuits as having a self-inductance which is completely different from the self-inductance calculated in the usual way. A resonant condition between the circuit elements is derived which guarantees the generation of approximately constant pitch of the field lines, thereby nicely confirming the model of a constant-pitch force-free field for the outer region of the screw pinch. In the general case, the solution of the full set of nonlinear equations is obtained as an expansion in a parameter which measures the deviation from the resonant condition and the amount of shear created. (auth)

**19400** NONLINEAR IONIZATION WAVES AND THEIR PARTICLE-LIKE PROPERTIES. Grabec, I.; Mozina, J. (Univ., Ljubljana, Yugoslavia). Beitr. Plasmaphys.; 14: No. 1, 1-5 (1974).

A nonlinear equation for ionization waves is derived and numerically solved under a spatially periodic initial condition. The solutions reproduce the essential features of striations in a positive column of an inert gas at a constant high discharge current and a pressure of the order of 1 torr. The calculated distributions of charged particles concentration indicate that high amplitude striations can be treated as particles. (auth)

**19401** ZAKLADY KLASICKE A KVANTOVE FYZIKY PLAZMATU. (BASIC CLASSICAL AND QUANTUM PLASMA PHYSICS). Kracik, J.; Sestak, B.; Aubrecht, L. Prague; Ceskoslovenska Akademie Ved (1974). 317p. (In Czech). 30,-Kcs.

This work comprehends the basic new elaborations and the latest knowledge on the physics of plasma, which examines the regularity and their mutual connections for the classical and quantum microscopic systems in dynamic equilibrium. The book originated from lectures of the authors at various institutes of higher education and from research on special and general questions on the physics of plasma at the Physics Department, Faculty of Electroengineering, the Czech Technical University in Prague. (auth)

**19402** INTRODUCTION TO PLASMA PHYSICS. Chen, F. F. New York; Plenum Publishing Corporation (1974). 336p. $18.00.

This book covers fluid equations for plasma diffusion and resistivity, distribution functions and kinetic equations, types of instability in plasmas, orbit theory, modes of oscillation, and Landau damping. Current research on sheaths and shock waves is analyzed. A summary of recent advances in controlled fusion is given. (MOW)

**19403** IONIZATION TURBULENCE. Grabec, I.; Mikac, S. (Ljubljana Univ., Yugoslavia). Plasma Phys.; 16: No. 12, 1155-1165(Dec 1974).

The development of ionization turbulence in the positive column of a glow discharge is simulated by the numerical treatment of a nonlinear ionization wave equation. The calculated distributions of electron density, ionization frequency and temperature show three characteristic phases of a developing turbulence. In the first phase the unstable growth of low amplitude fluctuations represents a linear phenomenon. In the second phase non-linearities appear, which in the third phase lead to saturation. The fluctuations in the third phase are represented by a random series of colliding shock-like striations. The turbulence in this phase is statistically stationary and homogeneous and can be characterized by the correlation function of electron concentration. The calculated correlation function reproduces all the essential features of ionization turbulence observed previously in experimental investigations. In particular, the backward character of random striations is clearly shown. (auth)

## Plasma Production

**19404** (CEA-R-4606) THEORETICAL INVESTIGATIONS OF LASER DRIVEN PLASMA FLOWS. Bobin, J. L. (CEA Centre

d'Etudes de Limeil, 94—Villeneuve-Saint-Georges (France)). Jan 1975. 153p. (In French). Dep. NTIS (US Sales Only) $10.75.

Thesis. Submitted to Paris Univ., Orsay, France.

By means of gasdynamic equations completed by terms taking into account energy and momentum exchanges between radiation and the fluid, properties and the structure of laser-created plasmas are described. Steady state solutions are determined whenever they exist. Light absorption and coherent scattering (generation of harmonics with half integer order) are specially investigated. (auth)

## Plasma Stability

*Refer also to abstract 19376.*

**19405** (SAND-74-0181) EFFECT OF RADIAL CONDUCTING BOUNDARIES ON TWO-STREAM INSTABILITY. Poukey, J. W.; Toepfer, A. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). Aug 1974. Contract AT(29-1)-789. 14p. Dep. NTIS $4.00.

The interaction of an electron beam and a plasma confined in a conducting cylinder by a large axial magnetic field is studied using two-dimensional electrostatic simulation code and linear dispersion theory. The radial variation of the electric field causes considerable differences from the ordinary one-dimensional results; however, field energy saturation due to particle trapping is still observed. (auth)

**19406** (UCID-16647) HOSE INSTABILITY OF A BEAM WITH THE BENNETT PROFILE. Lee, E. P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Dec 1974. Contract W-7405-eng-48. 22p. Dep. NTIS $4.25.

The hose instability is examined for an unmodulated beam with the Bennett current profile $J(r) \propto (1 + r^2/a^2)^{-2}$. The channel conductivity $\sigma(r)$ is also assumed to be of this form. To model particle orbit effects the beam is represented as a collection of independent disks with distribution of response frequency appropriate for the Bennett equilibrium. An effective decay length for dipole currents is determined by requiring that the well-known low frequency dispersion formula be recovered. The maximum growth rate for a disturbance propagating backwards in the beam frame is found to be $\omega_i = 5.52$ in units of the inverse skin length. (auth)

**19407** THRESHOLD FIELDS OF PARAMETRIC INSTABILITIES. Larsson, J.; Stenflo, L. (Univ., Umea, Sweden). Beitr. Plasmaphys.; 14: No. 1, 7-14(1974).

The threshold electric fields of parametric decay instabilities in a magnetized plasma were derived. Consideration is given to a unified presentation of a number of basic processes of particular interest. (auth)

**19408** NUMBER OF PROBLEMS IN THE KINETICS OF A NEUTRAL CURRENT LAYER. Bulanov, S. V.; Syrovatskii, S. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 74: 88-107(1974). (In Russian).

Attention is devoted to the propagation of waves of various types in a thin neutral current layer. Dispersion equations are obtained by a kinetic approximation for oscillations in the layer. A study is carried out on bunching instabilities and tearing-type electromagnetic instabilities in neutral layers. By a nonrelativistic approximation it is shown that the current layer in a nonstationary external electric field directed longitudinally to the current is unstable with respect to tearing-type electromagnetic instabilities (tearing). In the ultrarelativistic approximation, if the electric field increases sufficiently fast ($E_z \sim t^m$, $m > 1$) the current layer is stable with respect to tearing. Three simple models of charged-particle acceleration in neutral fields are constructed: acceleration of particles of a surrounding plasma, acceleration of particles into a layer with rapid decay of the current layer, and particle acceleration with the incidence of an electromagnetic pulse of sufficiently large amplitude into the layer. Attention is given to a simple model describing the decay of the current layer. It is shown that the electric field occurring in tearing has an amplitude $E \sim v/c\ H_0$ is the strength of the external magnetic field, and v is the characteristic velocity of the plasma into the layer. 35 refs. (SJR)

**19409** PARAMETRIC INSTABILITIES IN TURBULENT, INHOMOGENEOUS PLASMA. Nicholson, D.R.; Kaufman, A.N. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 33: No. 20, 1207-1210 (11 Nov 1974).

It is known that parametric instabilities involving two coupled modes, with oppositely directed group velocities, saturate convectively if the medium is inhomogeneous. This work considers the modification of that result when weak long-wave turbulence is present, in addition to the background inhomogeneity. We find that the convective saturation disappears when the turbulence exceeds a certain level, absolute growth occurring instead. (auth)

**19410** INTERACTION OF A WARM PLASMA COLUMN WITH HIGH-FREQUENCY ELECTRIC FIELDS: PURELY GROWING PARAMETRIC INSTABILITY. Zhelyazkov, I.; Nenovski, P. (Sofia Univ.). J. Phys., A (London); 7: No. 17, 2223-2235(21 Nov 1974).

A formalism for the derivation of the dispersion relation for potential surface waves which can propagate on a bounded warm plasma (plasma column) immersed in a high-frequency electric field $E = E_0 \sin \omega_0 t$ is described. The dispersion relation is examined for the case of strong and weak external electric fields. The threshold field and the growth rate of the purely growing surface parametric instability in a warm plasma column are obtained. It is shown that the threshold of purely growing surface instability for a plasma column is not higher than the threshold of decay (periodic) parametric instability for the same column. (auth)

**19411** FEEDBACK STABILIZATION OF M.H.D. INSTABILITIES IN TOKAMAKS. Hugill, J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Plasma Phys.; 16: No. 12, 1200-1202 (Dec 1974).

Previous work on MHD instabilities in Tokamaks has shown them to be of the reactor type, which are intrinsically more difficult to stabilize by feedback. It is shown that a proper choice of the frequency dependence of the feedback gain can, in principle, overcome this difficulty. (UK)

**19412** RATE EFFECTS ON INSTABILITIES IN SLIGHTLY IONIZED PLASMAS. Harstad, K. G. (Jet Propulsion Lab., Pasadena, CA). Plasma Phys.; 16: No. 12, 1177-1185(Dec 1974).

Presented are results of numerical computer calculations of dispersive wave growth rates in slightly ionized plasmas. The effects of employing a plasma model with detailed consideration of rate and radiative processes involving the electron quantum states are studied. Acoustic and electrothermal waves in unseeded argon are found to be frozen with the latter damped. Rate-thermal modes can exhibit large growth. Mode mixing and switching in both seeded and unseeded argon are demonstrated. (auth)

## Thermonuclear Engineering and Equipment

**19413** (AED-CONF-74-406-001) THE FUSION REACTOR: PHYSICAL AND TECHNICAL PROBLEMS. Wienecke, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). 1974. 25p. (In German). INIS.

From 38th meeting of physicists' of the Deutsche Physikalische Gesellschaft e. V.; Nuernberg, F. R. Germany (23 Sep 1974).

16 figs.; 3 tabs.

The review lecture deals with the following topics: physical fundamentals of nuclear fusion (fusion reactions, basic conditions for a fusion reactor, Lawson criterion), properties of a plasma (single particle model and magnetohydrodynamic model, particle force equation, gyration and drift movement with charge separation, transport coefficients, magnetic plasma confinement, the parameter $\beta$, the Ohms law), devices with magnetic confinement (mirror devices, tokamaks and stellarators with enumeration of plants in planning stage or under construction, pinch devices (principle, theta and screw pinch)), the principle of inertial confinement by high-power pulse lasers, as well as concept and technological problems of the fusion reactor, its advantages and prospects. (GE)

**19414** (ANL-Trans-967) POSSIBILITY OF CREATING A HIGH INTENSITY SOURCE OF NEUTRONS WITH AN ENERGY OF 14 MILLION ELECTRON-VOLTS. Begramekov, L. B.; Esenov, S. G.; Zhdanov, S. K.; Igritskii, A. N.; Jurnayef, V. A.; Smirnov, V. M.; Telkovskii, V. G.; Chikhachev, A. S. 1974. Translation of O Vosmozhnosti sozdaniya visokointensivnovo istochika neitronov s energiei 14 mev. (CONF-741105-52). 11p. Dep. NTIS $4.00.

From 5th conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

Preliminary studies of the prospects of creating a neutron generator with the use of both a solid target (under dynamic conditions with preliminary saturation) and gas targets indicated that a neutron generator with a solid target allows one to obtain a yield of neutrons $Y \lesssim 1$ to $3 \times 10^{14}$ n/sec with a beam power of $P \lesssim 400$ kilowatts, but a neutron generator with a gas target can provide $Y \leq 10^{15}$ n/sec with beam power $P = 600$ kilowatts. A number of problems were discovered which must be studied for creation of

the neutron generator. The most important of these for the variants mentioned are, respectively: (1) study of the physical properties of a solid target, including diffusion of the particles introduced and the question of blister formation; and (2) explanation of the character of distribution of the energy introduced by the beam of ions in the gas stream, and also development of a system of introducing the beam into a tritium stream. (auth)

**19415** (LA-5832-MS) HEAT TRANSFER MODEL FOR COMPOSITE FIRST WALL MATERIALS IN A PULSED HIGH-BETA CONTROLLED THERMONUCLEAR REACTOR (CTR). Tester, J. W.; Herrick, C. C. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1975. Contract W-7405-eng-36. 45p. Dep. NTIS $4.00.

A computer model was constructed to predict temperature and time excursions for radial composite walls currently under consideration for pulsed high-beta Z-pinch machines. The effects of incident flux, internal heat distribution functions, thermal properties, and material dimensions have been examined for a Nb/$Al_2O_3$ composite to establish the feasibility of the model. (auth)

**19416** (LBL-3335) PERFORMANCE OF LBL 20-kV, 10-A, AND 50-A NEUTRAL-BEAM INJECTORS. Berkner, K. H.; Baker, W. R.; Cooper, W. S.; Ehlers, K. W.; Kunkel, W. B.; Pyle, R. V.; Stearns, J. W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1974. Contract W-7405-eng-48. 5p. (CONF-741019-11). Dep. NTIS $4.00.

From symposium on ion sources and formation of ion beams; Berkeley, California, USA (22 Oct 1974).

Two pulsed neutral-injection systems developed at the Lawrence Berkeley Laboratory are described. The first has a 7- × 7-cm extraction array of 21 slots. It produces a 20-keV 30-msec deuterium ion beam of ~ 16 A, which is converted to energetic neutrals in a close-coupled neutralizer; 13 A equivalent of ions and neutrals are delivered in ±1.8° × ±3.6°, and 9.5 A are within ±0.6 × ±1.8°. The second system is a scaled-up version with a 7- × 35-cm extraction array. With a 10-msec extracted ion beam of ~ 75 A (1.5 MW) at 20 keV, it delivers 67 A (1.34 MW) within ±2° × ±4° of which 47 A (0.94 MW) are within ±1° ±2°. (auth)

**19417** (NIIEFA-B-0183) FORMING THE AXYSYMMETRICAL MAGNETIC FIELDS. Doinikov, N. I. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1973. 10p. (In Russian). INIS.

The problem of synthesizing a three-dimensional current system having symmetrical rotation was examined in the general case. All necessary formulas for variants were obtained, i.e., spheres, elongated and flattened rotation ellipsoids, and circular tori. (tr-auth)

**19418** (SAND-74-5274) EBFA, A TWENTY TERRAWATT ELECTRON BEAM ACCELERATOR. Martin, T. H.; Prestwich, K. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. 16p. (CONF-741113-5). Dep NTIS $4.00.

From international conference on energy storage, compression and switching; Turin, Italy (5 Nov 1974).

The design for an accelerator (EBFA) for studying electron beam driven, inertially confined fusion is described. The EBFA will generate two 3 MV, 20 nsec electron beams in back-to-back diodes with a total beam energy of 200 kJ and a peak power of $2 \times 10^{13}$ watts. The major components of the accelerator are Marx generators, intermediate storage capacitors, pulse forming lines, transmission lines and diodes. Six to eight, 3 MV, Marx generators operated in parallel will charge 24 intermediate storage, water-dielectric capacitors in approximately 1 μsec. The pulse forming lines consisting of two 24-meter diameter disc-shaped oil dielectric Blumleins, are charged in 100 nsec by the simultaneous discharge of the intermediate storage capacitors through triggered gas switches. Several hundred switch channels closing in less than 3 nsec will be required to produce a 10 nsec risetime output pulse. The voltage pulses are then transmitted through the disc-shaped transmission lines to the back-to-back diodes where the electron beams are generated and focused onto a spherical target. (auth)

**19419** (STI/PUB-23(Suppl.74)) FUSION REACTOR DESIGN PROBLEMS. Nuclear Fusion Special Supplement 1974. Proceedings of an IAEA Workshop Held at Culham, England, January 29–February 15, 1974. (International Atomic Energy Agency, Vienna (Austria)). Oct 1974. 547p. (CONF-740131-; ISBN-92-0-139074-2). $25.00.

A separate abstract was prepared for each of the 30 papers presented at the conference. (MOW)

*For abstracts of individual papers see: 19379, 19380, 19392, and 19424–19450.*

**19420** (UCID-16576) MIRROR PROGRAM PLANNING NOTES. Fowler, T. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Aug 1974. Contract W-7405-eng-48. 11p. Dep. NTIS $4.00.

Charts are presented that represent a compilation of present thinking about Mirror Program Planning. This is not a plan as yet and is in fact intended to help stimulate discussion of plans. The general theme here is building up by high current injection on a laser-induced target plasma column as small in diameter as possible in order to minimize the volume to be filled; namely, a diameter equal to the focal spot of convergent neutral beams (order of 6 to 10 cm). The concept is to build up to $\epsilon_e = \omega_{pe}^2/\omega_{ce}^2 > 1$ in a few hundred microseconds starting from a target with containment $n\tau = 10^{10}\text{cm}^{-3}$ sec, followed by further buildup from the initial core to fill the full machine, and then followed by steady-state beams. The 2XIIB experiment will stimulate these processes (except steady state) and Baseball II will be utilized to develop laser-target plasmas and, later, to demonstrate steady state. The MX will embody these ideas in a larger device. (auth)

**19421** SHIELDING PROBLEMS IN FUSION REACTORS. Blow, S. (UKAEA Research Group, Harwell, Eng.); McCracken, G. M. pp 198-214 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The radiation shielding problems which have been identified at the current stage of fusion reactor development are briefly discussed. The topic selected from this problem list for major discussion is the need to protect the superconducting magnet from radiation penetrating through the main shield. The effects which require assessment are the nuclear heating occurring in the cryogenic magnet region and the displacement damage caused by the neutron flux. It is shown that at power levels required for economic operation the damage effect is the more serious. (FR)

**19422** PRODUCTION OF DENSE THERMONUCLEAR PLASMAS BY INTENSE ION BEAMS. Winterberg, F. (Univ. of Nevada, Reno). Plasma Phys.; 17: No. 1, 69-77 (Jan 1975).

From electrostatic and electromagnetic confinement of plasmas and the phenomenology of relativistic electron beams; New York, NY (4 Mar 1974).

For very high density plasmas, as they are considered for nuclear fusion (or fission) micro-explosions, large energy accumulation within a small volume is required. As an alternative to laser- or relativistic electron beams and which are under study to achieve this goal, the employment of intense non-relativistic beams of heavy ions is considered, and which are to be produced in magnetically insulated diodes. Because of the rather low ion velocities, the beams can be axially compressed thereby shortening the duration of the beam pulse and increasing the beam power by perhaps several orders of magnitude. The axial beam compression is achieved by raising the voltage at the diode during the pulse whereby the ions emitted at a later instance catch up with the ions emitted earlier. By properly shaping the voltage pulse one can make the ions arrive simultaneously at a common center of convergence. Furthermore, by properly shaping both the voltage and current pulse one can obtain the conditions for adiabatic high density pellet compression as it was originally proposed for laser fusion. In this case several beams would have to be projected onto a common center of convergence at which the pellet is placed. The low ion velocities make it possible to build up the beam rather slowly in about $10^{-6}$ sec, prior to its axial compression and delivery to the target. This long build up time may permit the use of cheap inductive energy storage devices to drive the beam. In case capacitors are used one can simply pulse the beam with the upper terminal of a Marx generator. (auth)

**19423** ANTICIPATED DEVELOPMENT OF CONTROLLED THERMONUCLEAR ENERGY. Breton, D. (CEN, Fontenay-aux-Roses, France). Rev. Fr. Energ.; 25: No. 265, 215-235 (Aug 1974). (In French and English).

The studies of prospects carried out in the principal countries interested in thermonuclear energy conclude, in general, that it is at the end of the century or the beginning of the next that fusion energy will reach the industrial stage. Two roads are actually envisaged for controlled thermonuclear fusion. The magnetic confinement has been investigated through open or closed (Tokamak) magnetic configurations. Studies are now beginning on a European machine of the Tokamak type, the JET, but the programs do not predict that the production of electricity from experimental thermonuclear fusion reactors will be possible before the end of 1990. Very powerful lasers will be necessary for the thermo-

nuclear microexplosion to succeed. If the progress with lasers continues, the demonstration of feasibility of microexplosion is foreseeable in the years to come. Two to five years seem to be a reasonable order of magnitude but no absolute answer can be given, at the present time, to the question of the means to be used for the industrial extraction and uses of the energy produced in a thermonuclear microexplosion. The general characteristics of fission and fusion energy are compared. (FR)

**19424** 2100 MW(e) FUSION POWER PLANT. Tenney, F. H. (Princeton Univ., NJ). pp 17-25 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

A "first generation" 2100 MW(e) fusion power plant using a DT-burning Tokamak reaction is described. Some reactor parameters are: 10.5 m major radius; 3.25 m minor radius; 14.6 MA discharge current; q = 2.0; B = 6T. Helium cooling is used throughout. Tritium is bred in flibe. The blanket structural material is a nickel-iron alloy, PE-16. Operation of the reactor with its poloidal field divertor is described. (auth)

**19425** CONCEPTUAL DESIGN OF A GAS-COOLED TOKAMAK REACTOR. Sako, K.; Ohta, M.; Seki, Y.; Yamato, H.; Hiraoka, T.; Tanaka, K.; Asami, N.; Mori, S. (Japan Atomic Energy Research Inst., Tokai). pp 27-49 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

A conceptual design of a helium-cooled Tokamak reactor was carried out. Core plasma, reactor structure, blanket neutronics and material of the reactor are evaluated. The main design parameters of the fusion reactor are: reactor output 2000 MW(th), first-wall loading 2 MW/m$^2$; plasma major/minor radius 10/2m; average toroidal magnetic field 60 kG; and reactor inlet/outlet coolant temperature 400/600°C. $Li_2O$ pebble and Incoloy 800 are used for the blanket fertile material and the first-wall material respectively. (auth)

**19426** CONCEPTUAL DESIGN OF A 5000 MW(th) D-T TOKAMAK REACTOR. Kulcinski, G. L.; Conn, R. W. (Univ. of Wisconsin, Madison). pp 51-77 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The results of self-consistent design effort on a large Tokamak fusion reactor are presented. The reactor, fuelled with a deuterium-tritium mixture, operates at 5000 MW(th) and uses 316 stainless steel as a structural material. A compatibility problem between the liquid lithium coolant and the steel limits the operating temperature to 500°C and the electrical output to 1500 MW(e). The ion temperature of the 5-m radius plasma is 11.1 keV and the mean confinement time and fractional burn-up are 14.2 seconds and 7.2% respectively. A double-null poloidal divertor is used to protect the plasma from impurities. Cryogenically stabilized niobium-titanium superconducting magnets are used to provide a 3.82 tesla field on the plasma axis. Neutron and photon transport calculations indicate that the breeding ratio in UWMAK-I is 1.49 and doubling times may be as low as 2 to 3 months. The tritium leakage is 10.1 Ci/d. The total energy per fusion neutron, including the 3.52-MeV $\alpha$ particle, is calculated to be 20.08 MeV. Radiation embrittlement of the stainless steel limits the first-wall lifetime to two years while swelling and/or surface erosion limits the wall life to about five years. Radioactivity and afterheat calculations reveal that after ten years of operation there will be $1.6 \times 10^9$ Ci of activity and 31 MW(th) of afterheat. (auth)

**19427** PRELIMINARY DESIGN OF A MINIMUM-SIZE TECHNICAL-FEASIBILITY TOKAMAK FUSION REACTOR. Bertolini, E. (EURATOM-CNEN, Frascati, Italy); Brunelli, B.; Engelmann, F. pp 79-81 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The convenient (minimum) size of a Tokamak-like reactor for demonstration of technical feasibility depends on physical and technological constraints. It turns out that, under reasonable conservative hypotheses, the plasma ring has a minor radius of 2 m and a major radius of 10 m, and produces a thermal power of about 200 MW. (auth)

**19428** FURTHER CONSIDERATIONS OF THE TOROIDAL DIFFUSE PINCH REACTOR. Bodin, H. A. B.; James, T. E.; Newton, A. A.; Rostagni, G. (Culham Lab., Abingdon, Eng.). pp 83-98 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl. 74); CONF-740131-.

Stable, high-$\beta$ (~30-40%), magnetic field configurations obtainable with the reversed field pinch form the basis of a pulsed reactor with risetimes ~ 1 second. Although similar to the Tokamak, the Pinch has advantages of: (a) using low magnetic fields, thus not requiring superconductors; (b) having a free aspect ratio; and (c) has already demonstrated operation at the required $\beta$ ~0.4. A comparison of capital costs shows that the Pinch will be cheaper than the Tokamak unless values of $\beta$ in that system much higher than in experiments of today are realized. Problems common to both systems, such as turbulent energy losses during the formation stage, are discussed and some observations are made on blanket designs. (auth)

**19429** ENGINEERING DESIGN STUDY OF A REFERENCE THETA-PINCH REACTOR (RTPR). Ribe, F. L. (Los Alamos Scientific Lab., NM); Krakowski, R. A.; Thomassen, K. I.; Coultas, T. A. pp 99-149 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

An engineering conceptual design study of a fusion reactor power plant based on the $\theta$-pinch concept is described. A high-$\beta$, D-T plasma is produced by means of a programmed pulsed magnetic field in an approximately toroidal chamber having major and minor radii of 56 m and 0.5 m, respectively. The field produces a short, fast implosion stage followed by a longer adiabatic compression stage during which the D-T fusion occurs. The D-T burn stage has a duration of ~0.080 s, and the cycle time is 10 s. To protect the first wall after the burn, a gas blanket is used to cool the plasma in a slowly decreasing magnetic field. The fusion reactor power plant consists of 10 major systems as follows: implosion heating, plasma compression and confinement, magnetic energy transfer and storage, first wall, blanket, biological shield, fuel supply and removal, fuel-ash reprocessing, lithium processing, and energy conversion. Liquid lithium is the primary coolant. Other materials include alumina, provisionally chosen as the first-wall insulator, niobium as the first-wall and blanket structural material, beryllium as the neutron breeder, and graphite as a moderator. Two energy conversion schemes are considered: a conventional, low-temperature system which uses a Na-steam cycle, and an advanced, high-temperature steam system which uses a potassium topping cycle. Special attention is given to plasma burn dynamics, overall energy balance, blanket neutronics and thermal response, radiation shielding, radiation effects on and corrosion of construction materials, thermal and irradiation response of the $Al_2O_3$-Nb first wall, and tritium recovery and containment. Unique features of the design include a novel superconducting magnetic-energy transfer and storage system and a modular blanket structure which permits easy access for maintenance. (auth)

**19430** ENVIRONMENTAL AND TECHNOLOGICAL IMPLICATIONS OF A THETA-PINCH FUSION POWER PLANT. Coultas, T. A. (Argonne National Lab., IL); Burke, R. J.; Krakowskii, R. A. pp 151-168 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Tritium and other radioactive effluents from this conceptual fusion power plant are quantified and discussed. Further technological requirements for the eventual construction and operation of the plant are identified. Development needs for the energy storage, gas blanket, first wall/blanket and plasma confinement systems are described. (auth)

**19431** DESIGN STUDIES OF MIRROR MACHINE REACTORS. Werner, R. W.; Carlson, G. A.; Hovingh, J.; Lee, J. D.; Peterson, M. A. (Lawrence Livermore Lab., CA). pp 171-187 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The purpose of this paper is to provide an overview of the mirror fusion reactor design study elucidated in a previous comprehensive report by the authors. The general methodology used is discussed, the reactor described and some design alternatives to the present approach enumerated. (auth)

**19432** CONCEPTUAL DESIGN OF AN OPEN-SYSTEM REACTOR WITH RF PLUGGING. Hatori, T.; Hiroe, S.; Miyahara, A.; Sato, T.; Takayama, K.; Watanabe, T.; Watari, T. (Nagoya Univ., Japan). pp 189-198 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The scheme of an open-system reactor is presented based on the use of cusp confinement with adiabatic rf plugging. The impurity problem of this reactor is essentially less than the toroidal one, because the rf plugging has the property of selective confinement for various e/m values. The disadvantage of this system is the necessity of rf power to plug fuel ions. This reduces the Q value of the system, but for a sufficiently large-scale reactor this factor can be neglected. (auth)

**19433** TOROIDALLY LINKED MIRROR REACTOR DESIGN. Cordey, J. G.; Watson, C. J. H. (Culham Lab., Abingdon, Eng.). pp 199-217 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

It has been proposed that the advantages of mirror confinement (including equilibrium and stability at high $\beta$) can be combined with those of toroidal confinement (especially the long containment time) by using neutral injection to maintain a steady-state anisotropic toroidal plasma in a confinement system consisting of a number of minimum-B mirrors linked toroidally. This containment concept is examined from the point of view of reactor design. In a first approximation, the magnetic field configuration within each mirror section can be taken as that of an optimized single mirror reactor, so that, with minor modifications, existing optimization codes can be used to determine the most favorable parameters and to estimate the overall system cost. In a more detailed study of the magnetic configuration, it is necessary to take into account the consequences of toroidal linking, and it is shown that these set a lower limit to the number of mirrors, which is probably in the range 8-16. At the lower end of this range, care must be exercised in shaping the magnetic axis if the containment of passing particles is to be preserved. (auth)

**19434** LASER-CONTROLLED THERMONUCLEAR REACTOR DESIGN PROBLEMS. Williams, J. M. (Los Alamos Scientific Lab., NM). pp 219-231 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Results of initial studies of laser-fusion central station power plants are discussed. Functional requirements of major subsystems are defined and conceptual subsystem components that may satisfy these requirements are described. Several reactor cavity concepts are considered, including a wetted wall concept, a dry wall concept, a magnetically protected concept, and a lithium vortex or Blascon concept. A 1000-MW(e) laser-fusion power plant, based on $CO_2$ laser technology and the wetted-wall reactor cavity design is described. Laser-fusion reactor design problems and technologies that require development are identified. (auth)

**19435** POSSIBILITY OF MHD ENERGY CONVERSION OF PULSED FUSION REACTORS. Velikhov, E. P.; Golubev, V. S.; Chernukha, V. V. (Inst. of Atomic Energy, Moscow). pp 235-239 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

A possible utilization of certain conduction and induction MHD generator (MHDG) types for pulsed fusion reactor energy conversion is discussed. Transformation of fusion into low-temperature heat energy is carried out in a blanket, which absorbs most of the nuclear radiation. Physical limits of attainable conversion efficiency, reactor plasma parameters (pressure 1 kbar; temperature 2-3 eV) and of working fluid choice are analyzed. Estimated parameters of a Faraday-type supersonic plasma MHDG with continuous electrodes (efficiency 0.4) and of an induction-type piston MHDG (efficiency 0.7) are given; electric power of these generators changes during the period of energy pulse. (auth)

**19436** SOME UNSOLVED PROBLEMS MOST ESSENTIAL TO PHYSICS AND TECHNOLOGY OF FUSION REACTORS. Kadomtsev, B. B.; Popkov, G. N. (Inst. of Atomic Energy, Moscow). pp 243-247 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The sequence and scope of steps in physical and technological studies made for designing a Tokamak-type fusion reactor which have been discussed in the literature are presented. The range of physical and technical problems to be solved on the installations of different generations are considered in the context of international co-operation. (auth)

**19437** CURRENT SUSTAINED BY A TRAVELLING WAVE WITH PHASE VELOCITY INCREASING IN TIME. Midzuno, Y. (Nagoya Univ., Japan). pp 265-267 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

An estimation is made of the required rf power for sustaining current in a Tokamak fusion reactor. An example of the results in the case of Golovin's model is found to be 1.5/Q GW (Q being the Q-value of the coil system), which is reasonably small in comparison with the output power of the reactor (5 GW). (auth)

**19438** TOKAMAK REACTOR OPERATING IN A CYCLE REGIME. Lysenko, S. E.; Popkov, G. N. (Inst. of Atomic Energy, Moscow). pp 269-283 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Calculations of the operation cycles for a D-T Tokamak fusion reactor are presented. Equations of energy balance and plasma particle balance are solved for various assumptions on plasma thermal insulation. It is assumed that the distributions of plasma temperature, concentration and current density over the cross-section are flat, and that both the ion and electron temperatures are equal. It is shown that impurities appreciably influence the ignition and rates of a fusion reaction. Restrictions imposed by $\beta$ limits are considered. Rate of nuclear power output of a fusion reactor can be made more uniform by using additional injection of fuel. Certain considerations on the reactor parameter optimization are presented. (auth)

**19439** THREE NOTES ON ENGINEERING ASPECTS OF FUSION REACTORS. Foerster, S. (Kernforschungsanlage, Juelich, Ger.). pp 287-295 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The three notes describe some engineering aspects of fusion reactors related to the renewal and maintenance of parts of the blanket. Note 1 describes an elastic energy distribution system with only electric power plants for electricity and synthetic fuel production, allowing for rather long shut-down periods of one large power plant (for maintenance and repairs). In Note 2 some solutions for segmented blanket arrangements of a toroidal fusion reactor with large $\beta$, $\phi$ coils are discussed. A design for a cellular blanket with low lithium content (enriched lithium) and for helium cooling is shown, for liquid lithium as well as for solid-state lithium compound. The design advantages are pointed out. (auth)

**19440** MATERIALS RESEARCH PROGRAMME FOR FUSION REACTORS. Zwilsky, K. M. (Atomic Energy Commission, Washington, DC). pp 297-303 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The type of materials research necessary for the development of fusion reactors is reviewed and divided into thirteen different areas. Some of the areas, such as surface radiation effects, have a strong interface with plasma physics, and information is needed almost immediately not only for reactors, but for the next generation of plasma experiments. Work in other areas such as the development of radiation-resistant alloys must be initiated now because of the long lead time required. Of greatest importance at this point in time is the definition of the specific materials requirements and the time scale for such requirements. (auth)

**19441** FUSION REACTOR TECHNOLOGY STUDIES AT OAK RIDGE NATIONAL LABORATORY, JUNE 1972-OCTOBER 1973. Steiner, D. (comp.). (Oak Ridge National Lab., TN). pp 309-340 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

ORNL fusion reactor technology studies from June 1972 to October 1973 are reviewed. These include chemical engineering, materials research, neutronics and system studies. (auth)

**19442** MINIMUM-ACTIVITY BLANKETS FOR COMMERCIAL AND EXPERIMENTAL POWER REACTORS. Powell, J. R.; Miles, F. T.; Aronson, A.; Winsche, W. E.; Bezler, P. (Brookhaven National Lab., Upton, NY). pp 343-345 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

A new concept for fusion-reactor blankets is examined. In this concept, tritium is bred in solid lithium compounds instead of liquid lithium or flibe. All components in the blanket are solids except for helium gas coolant. The bred tritium continuously diffuses out of the solid lithium compound and is recovered either by letting it go into the coolant stream, from which it is trapped, or by letting it escape into the vacuum region between the first wall and the plasma, where it mixes with the divertor exhaust. It is not necessary to remove the solid lithium compound for processing or to replenish it during the blanket lifetime, which can be as long as thirty years. (auth)

**19443** BLANKET COOLING WITH LIQUID METAL AS WORKING FLUID. Fujii-E, Y.; Suita, T. (Osaka Univ.). pp 347-362 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Three possibilities for blanket cooling of a fusion reactor with liquid metal as working fluid are discussed, mainly as concerns a low operating pressure system design, i.e., the MHD pressure drop decrease. They are: (1) introduction of an em pumping system inside the blanket by application of an external potential; (2) liquid metal and inert gas mixture as the working fluid to expect the low equivalent electric conductivity; and (3) boiling two-phase flow as the working fluid in which heat is transported in the form of latent heat of evaporation to lessen the mass flow rate as well as to expect a low equivalent electric conductivity of the two-phase flow. It can be said from the experiment and the calculation that the MHD pressure drops are reduced enough in each case. However, for the first case, the engineering problem, of introducing the electrode through which large current flows, should be solved and the stress on the wall due to the MHD interaction between the wall current and the magnetic field cannot be reduced. In the third case, both single- and two-component boiling two-phase flow reveal most promising and encouraging results in decreasing the MHD pressure drop as well as pumping energy loss. It has even the possibility of flattening the heat generation density along the blanket radius. (auth)

**19444** INTEGRAL EXPERIMENTS ON A SPHERICAL LITHIUM METAL BLANKET SYSTEM. Hiraoka, T.; Maekawa, H.; Seki, Y.; Hirota, J. (Japan Atomic Energy Research Inst., Tokai). pp 363-376 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

A spherical lithium metal system was assembled by lithium blocks to investigate the neutronics of the fusion reactor blanket. Reaction rate traverses were measured by fission chambers of $^{232}Th$, $^{238}U$, $^{237}Np$ and $^{235}U$ and by a $^{10}BF_3$ counter. Penetration of 14-MeV neutrons was also carried out. Their results were compared with the calculated results. It was established that the neutrons above a few MeV in the system were well evaluated. (auth)

**19445** BLANKET DESIGN WITH LOW LITHIUM AND TRITIUM INVENTORIES. Darvas, J. (Kernforschungsanlage, Juelich, Ger.). pp 377-383 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

For the fusion reactor blanket a design is proposed in which the lithium and tritium inventories are by about two orders of magnitude lower than in the hitherto standard design using liquid lithium. The proposed design uses enriched lithium (25% $^6Li$), Be for neutron multiplication and graphite to obtain a thermalized neutron spectrum. Some consideration is given to the engineering features of tritium recovery and of cooling in such a blanket. (auth)

**19446** GAS-BLANKET CONCEPT. Brandt, B.; Braams, C. M. (FOM-Instituut voor Plasmafysica, Jutphaas, Netherlands). pp 385-392 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The gas-blanket program of the Institute for Plasma Physics, Jutphaas, The Netherlands, is discussed. The concept of a gas blanket is defined, theoretical work in a steady-state cylindrical reactor is reviewed, the experimental program is briefly mentioned, and a number of outstanding problems are listed. (auth)

**19447** SUMMARY OF CALCULATIONS OF A WORKING GROUP ON A MODEL FUSION REACTOR BLANKET. Steiner, D. (Oak Ridge National Lab., TN); Blow, S. pp 395-398 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Seven laboratories in the United States of America and two from Europe participated in specifying a model to discover whether different calculation techniques had caused the discrepancies of up to 15% in tritium-breeding rates calculated for fusion reactor blankets which came to light during the International Working Sessions on Fusion Reactor Technology at Oak Ridge in 1971. The features of the model and the most important conclusions are presented. (auth)

**19448** IMPURITY PROBLEM IN STEADY-STATE TOROIDAL DEVICES. Taylor, J. B. (Culham Lab., Abingdon, Eng.). pp 403-407 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The impurity concentration in a steady-state device is estimated. The extreme difficulty of maintaining adequate purity, even with a divertor, is illustrated. (auth)

**19449** CRYOGENIC PUMPING OF A FUSION REACTOR. Yuferov, V. B.; Vojtsenya, V. S.; Skibenko, E. I.; Kholod, Yu. V. (Physico-Technical Inst., Kharkov). pp 419-430 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

Some estimates of operating conditions of a fusion reactor in torsatron configuration without longitudinal magnetic field windings are made. Some problems are discussed which deal with the protection of hot plasma from impurities emerging from the walls and methods of pumping them out. It is shown that at the present level of science and technology the development of reactor pumping devices is quite possible. (auth)

**19450** EXTRACTION OF TRITIUM FOR LIQUID LITHIUM. McCracken, G. M; Goodall, D. J. H.; Whipple, R. T. P., Long, G. (Culham Lab., Abingdon, Eng.). pp 439-448 of Fusion Reactor Design Problems. Vienna; International Atomic Energy Agency (1974).

From proceedings of a workshop on fusion reactor design problems; Culham, UK (29 Jan 1974). See STI/PUB-23(Suppl.74); CONF-740131-.

The partial pressure of deuterium above solutions of deuterium in liquid lithium was measured down to concentrations of a few ppm. The rate of diffusion of deuterium in lithium was also measured. The implications of these results for the extraction of tritium from the breeding blanket of a fusion reactor are discussed. (auth)

**19451** NUCLEAR FUSION—ENERGY SOURCE OF THE 21ST CENTURY. Kenward, M. Technica (Basel); 23: No. 14, 1187-1189(12 Jul 1974). (In German).

The prospects of achieving controlled nuclear fusion in the not too distant future are considered in the view of the recent encouraging results of plasma physics research at the U. K. Culham laboratory and elsewhere. (INIS)

## Wave Phenomena

**19452** (COO-2288-8) ABSORPTION OF ELECTROMAGNETIC WAVES NEAR THE CRITICAL DENSITY. Final Report, 1 Decem-

ber 1973–30 November 1974. Daiber, J. W.; Rehm, R. G.; Thompson, H. M. (Calspan Corp., Buffalo, N. Y. (USA)). 1973. Contract AT(11-1)-2288. 8p. Dep. NTIS $4.00.

The program is an experimental study of the interaction of high-intensity ruby-laser radiation with gas in a free jet. In these experiments, both laser intensity and the plasma frequency can be varied. By monitoring several parameters, including incident and reflected power, x-ray emission and the kinematics of plasma growth, the existence of an anomalous threshold for coupling radiation into plasma energy should be determinable. Measurements in hydrogen show that between one and two percent of the incident laser radiation was reflected when x-rays were detected and only when x-rays were detected. Within the resolution of the instrumentation, there was no reflected radiation when nitrogen was used as a target gas. An abrupt change in reflectivity as a function of laser power and of reservoir pressure was not found. (auth)

**19453** (IPP-1/147) ION SOUND SPECTRUM AND ELECTRON-WAVE INTERACTION IN PERPENDICULAR SHOCKS. Biskamp, D.; Chodura, R.; Dum, C. T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F. R. Germany)). Jul 1974. 10p. (IPP-6/126). INIS.

A theory is presented for the rotation of the ion sound spectrum with respect to the drift velocity as observed in perpendicular shocks. The results of 2D simulation confirm the main points of the theory and represent a direct verification of perturbed orbit theory or strong turbulence. (auth)

**19454** NON-LINEAR MODE–MODE COUPLING AT A PLASMA VACUUM TRANSITION LAYER. Barakate, A. R.; Dolgopolov, V. V.; El-Siragy, N. M. (Atomic Energy Commission, Cairo). Plasma Phys.; 17: No. 1, 89-95(Jan 1975).

An investigation is made of wave generation at combination frequencies for the oblique incidence of polarized electromagnetic waves on a semi-bounded plasma when the width of the plasma-vacuum transition layer is much less than the wavelength. The amplitudes of the waves radiated at combination frequencies are calculated. It is shown that the tangential electric field components of the waves at the combination frequencies are discontinuous at the plasma boundary. This explains the differences in the results from the corresponding results of earlier papers in which the tangential electric field components of higher harmonics at the plasma boundary were assumed to be continuous. (auth)

**19455** SECULAR FREE SOLUTION UP TO THIRD ORDER OF AN ELECTROMAGNETIC WAVE IN A COLD DISSIPATIVE MAGNETOACTIVE PLASMA MEDIUM. Chandra, S. K. (Krishna Chandra Coll., Hetampur Rajbati, India). Fizika (Zagreb); 6: No. 3, 127-133(Oct 1974).

The perturbation method of Lindstedt is applied to study the relativistic nonlinear effects of a circularly polarized transverse monochromatic wave in a cold dissipative plasma medium in the presence of static magnetic field which is along the direction of propagation of the wave. Amplitude dependent wave length and frequency shifts including relativistic corrections are derived. (auth)

**19456** STUDIES OF INTERNAL DISRUPTIONS AND m=1 OSCILLATIONS IN TOKAMAK DISCHARGES WITH SOFT–X–RAY TECHNIQUES. von Goeler, S.; Stodiek, W.; Sauthoff, N. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Rev. Lett. 33: No. 20, 1201-1203 (11 Nov 1974).

Fluctuations in x–ray intensity from the ST tokamak show a characteristic sawtooth behavior. This behavior is identified as an internal disruption. The internal disruptions are preceded by growing sinusoidal m=1, n=1 oscillations. The properties of these oscillations are compared with predictions for the m=1 internal kink mode. (auth)

**19457** DESTABILIZATION OF HYDROMAGNETIC DRIFT–ALFVÉN WAVES IN A FINITE–$\beta$, COLLISIONAL PLASMA. Tang, J.T.; Luhmann, N.C. Jr. (University of California, Los Angeles, California 90024); Nishida, Y.; Ishii, K. Phys. Rev. Lett. 34: No. 2, 70-73 (13 Jan 1975).

We have observed experimentally the destabilization of both the Alfvén and the drift branches of the hydromagnetic, coupled drift–Alfvén wave in a steady–state, high–density ($n_0 \simeq 10^{13}-10^{15}$ cm$^{-3}$) collisional plasma when an axial electron current is drawn along the magnetic field. The measured dispersion relation is in good agreement with solutions of our theoretical dispersion relation. (auth)

**19458** NORMAL MODES IN THE ION–BEAM–PLASMA SYSTEM. Grésillon, D.; Doveil, F. (Laboratoire de Physique des Milieux Ionisés, Ecole Polytechnique, 75230 Paris 5e, France). Phys. Rev. Lett. 34: No. 2, 77-80 (13 Jan 1975).

Two types of dispersion relations are experimentally shown to exist in an ion–beam–plasma system. For beam velocities close to the ion–sound speed, two normal modes, one unstable, are seen. For larger beam velocities, the interferometer output exhibits beating between the three predicted stable normal modes, which are the "fast" and "slow" ion–beam modes and the plasma ion–acoustic wave. (auth)

**19459** PROPAGATION OF SOLITARY WAVES IN A TWO ION SPECIES PLASMA WITH FINITE ION TEMPERATURE. Tran, M. Q. (Centre de Recherches en Physique des Plasmas, Lausanne, Switzerland). Plasma Phys.; 16: No. 12, 1167-1175 (Dec 1974).

The propagation of ion acoustic solitary waves in a two ion species plasma with $T_i \neq 0$ was studied using a Korteweg-de Vries equation. As the dispersion relation presented two acoustic branches with quite different phase velocities, two types of soliton were propagated; the slow one which is subsonic with respect to one ion mode and supersonic to the other, had greater amplitude and smaller width than the fast one. (auth)

**19460** MODE CONVERSION BY DOUBLE CERENKOV PROCESSES IN A PLASMA. Arunasalam, V. (Princeton Univ., NJ). J. Phys., A (London); 7: No. 17, 2211-2222(21 Nov 1974).

It is shown that the conversion of an electromagnetic wave (i.e., a transverse photon) to an electrostatic wave (i.e., a longitudinal plasmon) and vice versa can occur in a uniform, homogeneous and isotropic plasma by Cherenkov absorption of one kind (i.e., the photon or the plasmon) and the subsequent emission of the other kind (i.e., the plasmon or the photon, respectively). Furthermore, it is shown that there also exists an additional "stimulated mode conversion process". These mode conversions by double Cherenkov processes are of second order in the Heitler-Ma (Heitler, The Quantum Theory of Radiation, Oxford, Clarendon, (1954)) formulation of the quantum time-dependent perturbation theory. Explicit expressions for the cross sections appropriate to these mode conversion processes are also presented. (auth)

**19461** ON THE PROBLEM OF THE INTERACTION OF ELECTROMAGNETIC WAVES IN A NONLINEAR PLASMA OF SPHERICAL GEOMETRY. Bassanini, P. (Perugia Univ. (Italy)). Z. Angew. Math. Phys.; 25: No. 2, 209-228(25 Mar 1974). (In Italian).

The problem of the approximate determination of the electromagnetic field generated by two oscillating electric dipoles in the center of a spherical cavity imbedded in a nonlinear plasma is considered. The influence of the nonlinearities of the plasma upon the field is investigated by means of a perturbative solution of the relevant equations, deduced from the "quasi-hydro-dynamic" approach. Analytical and numerical results, which illustrate several nonlinear effects, as well as the influence of the rare-fraction and ionization of the gas, are included. The main result of the paper is the prediction of an observable second harmonic field. (auth)

**19462** STUDY OF THE NATURAL OSCILLATIONS OF CYLINDRICAL PLASMAS BY THE FINITE ELEMENT METHOD. Appert, K.; Berger, D.; Gruber, R.; Troyon, F.; Rappaz, J. (Ecole Polytechnique Federale, Lausanne (Switzerland)). Z. Angew. Math. Phys.; 25: No. 2, 229-240(25 Mar 1974). (In German).

The eigenmodes of a cylindrical homogeneous plasma may be calculated analytically. There are three classes of solutions. The eigenvalues of the first class are well separated, those of the second class have a point of accumulation. The eigenvalue of the third class is infinitely degenerated. The eigenvalues and eigenmodes of the corresponding discrete finite element problem tend towards the true solution. The convergence properties are discussed. (auth)

# ENGINEERING

## Energy Conversion

*Refer also to abstract 19435.*

**19463** (TID-26718) DRAFT GENERIC ENVIRONMENTAL STATEMENT ON THE WIDE-SCALE USE OF PLUTONIUM POWERED CARDIAC PACEMAKERS. (USAEC Directorate of Licensing, Washington, D. C.). Jan 1975. 202p. Dep. NTIS $13.25.

Nuclear-powered cardiac pacemakers have been developed which use plutonium (primarily the $^{238}Pu$ isotope) as a heat source in a thermoelectric converter battery. The relatively long half-life of $^{238}Pu$ (87.8 y) provides batteries with longer service life than conventional batteries and reduces the need for pacemaker reimplantations, thus reducing the surgical risk, pain, suffering and anxiety associated with replacement surgery. The Atomic Energy Commission has licensed the implantation of limited numbers of plutonium powered cardiac pacemakers under rigidly controlled investigations to establish that (1) nuclear pacemakers are safe and reliable, (2) widescale use will not subject the public to undue risk, and (3) the benefits derived by patients using nuclear pacemakers outweigh the risk to the public. This environmental impact statement considers the radiation safety standards which nuclear pacemakers are required to meet, the benefits to patients from the longer useful life of nuclear powered pacemakers, alternative pacemakers that are available or being developed, and the risks to the public and to the environment from the use of plutonium powered pacemakers. (TFD)

## Facilities and Equipment

*Refer also to abstract 19371.*

**19464** (LA-5826-MS) CHARACTERIZATION OF ROCK MELTS AND GLASSES FORMED BY EARTH-MELTING SUBTERRENES. Lundberg, L. B. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1975. Contract W-7405-eng-36. 13p. Dep. NTIS $4.00.

Rock melts and glasses formed by earth-melting Subterrenes have been studied in some detail. Data are presented on both the molten and the solid rock-glass products formed. The melting behavior, thermal transport, viscosity, electrical resistivity, and solidification behavior of several molten rock-glasses are described. The visual appearance, gas and water permeabilities, thermal expansion, thermal conductivity, and crush strength of several solid rock-glasses are also documented. (auth)

**19465** (RN-S-0498) HIGH-TEMPERATURE WATER PENETRATION TEST RESULTS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1969. 53p. Dep. NTIS $5.75.

Testing of a single stage of a nuclear rocket engine using hydrogen as a propellant necessitates a duct to carry the exhaust gases away from the stand to a point where they can be burned without damage to the test stand. With the engine mounted in a downward firing attitude, the exhaust duct carries the gases downward through a second throat diffuser that aids in achieving a low pressure environment for the engine, and through a 90° elbow where the gases are turned and subsequently directed away from the base of the stand. A study of a wet-duct system, or an exhaust gas system in which water is injected into the exhaust gases immediately after exiting from a supersonic diffuser is described. Injecting water into the gas stream results in an immediate reduction of the effective temperature of the gas stream, eliminating the need for secondary cooling of the duct walls and simplifying structural design problems. (TFD)

**19466** (RN-TM-0559) WATER JET PENETRATION OF A HIGH-VELOCITY GAS STREAM IN CROSS FLOW. Margetts, M. J.; Geery, E. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1967. 54p. Dep. NTIS $5.75.

Data on water jet penetration into a high-velocity, cross-flow of gas were obtained for nozzles ranging from 0.0625 to 1.5 inches in diameter. The range of nozzle sizes tested necessitated two types of tests. The initial, or Phase I, tests (nozzles with diameters ranging from 0.0625 to 0.5 inch) were conducted in a two-dimensional test section with a window forming one side. The second series, or Phase II, tests (nozzles with diameters ranging from 0.25 to 1.5 inches) were conducted in the NASA Lewis Research Center six by nine foot Icing Research Tunnel. The gas streams penetrated in the small-nozzle tests were either nitrogen or hydrogen gases at ambient temperatures or heated to 1500°R. The large diameter nozzles were tested in the wind tunnel flowing air at 35 to 40°F. Expressions for predicting the profile and spread of the jet were empirically derived. (auth)

**19467** (WANL-TME-183) PRELIMINARY FUNCTIONAL DESIGN INFORMATION FOR PROTOTYPE ETS TEST OPERATIONS CONSOLE. Margulies, A. E.; Kendziorek, M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 Oct 1962. 7p. Dep. NTIS $4.00.

Described are the panel controls and instrumentation shown on WANL drawing 934 J 970, ETS Test Operations Console, Reactor and Engine Panels Alt. III-A. It is assumed that the Reactor Panel will provide capability for the following functions: (1) pretest checkout of the engine nuclear subsystem including checkout of each rod individually, with associated actuating and control system, low power physics tests, monitoring of reactor protection system checks and simulator readiness runs; (2) monitoring of all essential nuclear subsystem parameters during the test run; and (3) monitoring programmed cooldown with manual override controls for backup and performance of post run physics tests. (auth)

**19468** (WANL-TME-260) COMMENTS ON "REQUEST FOR PROPOSAL" EG AND G RFP NO. 1183-3B ETS-1. Digital Data System, Functional Specifications and Attachment "A". Dippel, C. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 17 Jan 1963. 4p. Dep. NTIS $4.00.

**19469** (WANL-TME-315) JUSTIFICATION FOR WIDE BAND INSTRUMENTATION IN TEST CELL A. Norkin, H.; Schaedel, C. T. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 4 Apr 1963. 20p. Dep. NTIS $4.00.

Factors justifying the procurement of 195 channels of wide band instrumentation for use at Test Cell "A" during NRX-A-1 testing are presented. (WHK)

**19470** (WANL-TME-1263) WANL WIDE BAND DATA CONVERTER. Blau, P.; Moran, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1965. 30p. Dep. NTIS $4.50.

The WANL wide band data converter is used in the reduction and analysis of data taken in NRX testing at NRDS. The device is a high-speed multiple-input analog-to-digital converter and tape formatting unit, capable of handling wide band (to 1000 cycles) data at sufficient rates to prevent aliasing, and with a reasonable degree of conversion accuracy. Because it occupies a significant place in the handling of NRX data, tests were conducted on the wide band data converter to determine the overall accuracy of the device in converting test data. Known inputs were introduced into the discriminator section directly from tapes and the corresponding outputs measured at the converter section output. Separate tests were made to determine drift (long and short term), linearity, and cross talk. No attempt was made to analyze aliasing errors; the sampling rate may be made sufficiently high to eliminate such errors. (auth)

**19471** (WANL-TME-1372) TEST CELL A NARROW BAND DATA ACQUISITION ACCURACY TEST EVALUATION. Horton, W. H.; Blau, P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1966. 128p. Dep. NTIS $9.50.

This report presents the results, and a description of how they were obtained, of an accuracy test of the narrow band data acquisition system at Test Cell "A". The test was proposed because the quality of the NRX vehicle design and performance is dependent on the knowledge of the accuracy of the test measurements. Prior to this test conflicting opinions existed as to the accuracy of the Test Cell "A" data system. (auth)

**19472** (WAPD-TM-1190) THERMAL STRESSES ON THE SURFACE OF PERFORATED PLATES WITH TEMPERATURE DISTRIBUTIONS VARYING THROUGH THE THICKNESS ONLY. Jones, D. P. (Bettis Atomic Power Lab., Pittsburgh, Pa. (USA)). Dec 1974. Contract AT(36-1)-GEN-14. 41p. Dep. NTIS $5.25.

Numerical finite element solutions for the thermoelastic stresses near penetrations in plates are presented. Consideration is given to both plates with a single penetration and to plates containing a uniform array of penetrations arranged in a triangular pattern. Results are given for thermal shock, linear temperature distribution through the thickness, and quadratic temperature distribution through the thickness. For the plates

subjected to thermal shock, no stress concentration was found at the penetration boundary. The thermal stresses at the surface of perforated plates subjected to linear and non-linear temperature gradients through the thickness were found to vary around the ligament edges in the same manner as the stresses induced by equivalently applied mechanical loads. (auth)

**19473** (Y-DA-6003) THERMAL STRESS TESTING SYSTEM FOR GRAPHITIC MATERIALS. Turner, P. C. (Oak Ridge Y-12 Plant, Tenn. (USA)). 30 Dec 1974. Contract W-7405-eng-26. 28p. Dep. NTIS $4.50.

A system was needed for precisely measuring and recording four parameters for thermal stress testing of graphitic materials. For this test, a disc sample is thermally stressed by applying an electric arc to its center. By measuring and recording arc voltage, arc current, sample peripheral temperature, and sample radial expansion, the system provides data for determining the relative thermal stress resistance and the coefficient of thermal expansion for each sample. To provide these capabilities, a digital recording system was developed. Digital panel meters are used to convert the measured voltages to digital signals. Outputs of the panel meters are then printed out via a digital printer. Techniques were developed to convert sample peripheral temperature and radial expansion to corresponding voltages for recording purposes. Spring-loaded thermocouples contact the bottom side of the disc sample and provide temperature measurements at the periphery. Four commercially available linear variable differential transformers (LVDT) were provided with quartz-rod tips and radiant thermal shielding for measuring expansion. A test fixture was developed for holding the transducers in contact with the sample. The measurement precision for each parameter was verified by laboratory tests. Samples with known physical properties were tested with this system, and the results were as expected. (auth)

**19474** CW HIGH-PRESSURE TUNABLE $CO_2$ LASER WITH A MIXTURE OF $CO_2$ ISOTOPES. Beterov, I. M.; Chebotayev, V. P.; Provorov, A. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). IEEE J. Quant. Electron.; QE-10: No. 2, 245-247(Feb 1974).

The qualitative theory of the $CO_2$ laser at atmospheric pressure is developed. Investigations of a cw $CO_2$ laser at high pressure with conventional and waveguide resonators and obtaining cw oscillation in the mixture of three isotopic molecules, $^{12}C^{16}O_2$, $^{12}C^{16}O^{18}O$, and $^{12}C^{18}O_2$, are reported. The problem of building a super-high-resolution spectrometer on the basis of a cw high-pressure $CO_2$ laser with mixed isotopes is discussed. (auth)

## Lasers

*Refer also to abstract 20322.*

**19475** (AD-774908) LASER KINETIC DATA DEVELOPMENT. Final Report, 29 December 1972-29 December 1973. Menne, T. J. (McDonnell Douglas Research Labs., St. Louis, Mo. (USA). Radiation Sciences Dept.). 29 Dec 1973. Contract DAAHO1-73-C-0372. 35p. (MDC-Q-0510; RK-CR-73). NTIS $3.25.

The objectives of this contract were to investigate the possibility of a CO chain reaction chemical laser based on $O_2$ + CS chemistry and to model various schemes, particularly gas dynamic expansion, for extracting more power from CO chemical lasers. The direct reaction of $O_2$ + CS was investigated experimentally. Measurements of the vibrational energy distribution of CO from the CS + $O_2$ reaction with a Fabry-Perot microwave resonator/CO chemical laser system were also part of the effort on the first objective. The second effort involved the CO chemical laser modeling code developed under a previous MICOM contract. This computer program was modified to include the cooling effects of gas dynamic expansion through a supersonic nozzle on chemically-formed CO. Both nozzle-cooled and non-nozzle-cooled chemical lasers were modeled. The modeling code was further modified to determine the effect of gas additives on the laser output characteristics. (auth)

**19476** (AD-777810) OPTICAL PUMPS FOR HOLMIUM LASERS. Triannual Report No. 2, 1 November 1972-28 February 1973. Noble, L.; Maynard, R.; Flentz, H. (ILC Technology, Inc., Sunnyvale, Calif. (USA)). Dec 1973. Contract DAAB07-72-C-0274. 29p. (ECOM-0274-2-72). NTIS $4.50.

The purpose of the program is to produce more efficient pulsed optical pumps for use with holmium-doped yttrium lithium fluoride laser materials (Ho:YLf). Prior to this program, the best efficiency obtained was a lasing threshold at 8 J input and 20 MJ laser output at 10 J input. The most efficient optical pump now appears to be a clear fused quartz lamp of 2.5 to 3.0 mm bore diameter filled with xenon to high pressure, e.g., 4500 torr, and operated with a simmer current. The mode I goal of 30 MJ output for 10 J input has been exceeded by a factor of two using a 3 mm bore, 3000 torr lamp. However, the mode II goal of 100 MJ output for 10 J input will require further lamp improvements and perhaps cavity improvements as well. (auth)

**19477** (AD-782233) OPTICAL PUMPS FOR LASERS. Final Report, 24 April 1972-23 June 1973. Newell, P. B. (EG and G, Inc., Salem, Mass. (USA)). Mar 1974. Contract DAAB07-72-C-0165. 77p. (ECOM-0165-F-72). NTIS $4.00.

The specific objective was to investigate and improve those lamp design and operating parameters which affect laser beam quality in a given laser cavity. The parameters which were investigated included: gas fill and gas pressure, arc diameter, preionization techniques, laser rod size, and laser rod surface condition. The lamps were evaluated in free air, in a fluorescence measuring device, and in actual laser cavities. (auth)

**19478** (AD-784995) ANALYSIS OF VUV AND X-RAY LASERS PUMPED BY A TRAVELING-WAVE SOURCE. Bey, P. P. (Naval Research Lab., Washington, D. C. (USA)). Jul 1974. 22p. (NRL-MR-2847). NTIS $3.00.

A numerical analysis is made to account for the intensity of amplified spontaneous emission (ASE) as a function of the length of the amplifying medium pumped by a traveling-wave photon source. Details of the analysis are given for sodium vapor at 372 Å pumped by a broad band traveling-wave photon source. A calculation is also included to determine the feasibility of producing ASE at 372 Å with a 100 eV black-body like source produced, for example, by an exploding wire. Results indicate that ASE is not feasible with exploding wire technology unless the presently available intensity or rise time can be improved by a factor of ten. Results are also given for amplifying K alpha emission from aluminum and copper at 7.84 Å and 1.54 Å, respectively. (auth)

**19479** (IPP-IV-69) A CONTINUOUSLY OPERATING SUBSONIC HIGH-POWER cw-HF-LASER. Proch, D.; Pummer, H.; Wanner, J. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F.R. Germany)). Jul 1974. 18p. (In German). INIS. 8 figs.; 24 refs.

A continuously operating hydrogen fluoride laser, operating in the subsonic flow regime, is described. Details of the experimental setup are given. The maximum power is 40 W with a stability of 3%. Spectrum measurements show the appearance of up to 14 different vibrational-rotational transitions, belonging to the $P_{(2-1)}$ and $P_{(1-0)}$ bands, respectively. The influence of gas temperature on the relative intensities of the spectral lines is investigated. (auth)

**19480** (UCID-16693) KILOJOULE LASER SYSTEM SPATIAL FILTER ANALYSIS. Weaver, H. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Apr 1973. Contract W-7405-eng-48. 24p. Dep. NTIS $4.25.

An analysis of a spatial filter subsystem for the kilojoule laser system is presented. It is assumed that the oscillator output beam has a Gaussian profile with cosinusoidal structure imposed on it. The report indicates how to choose the optical elements of the spatial filter system to remove this structure and how to analize other forms of structure. (auth)

**19481** EXPERIMENTAL STUDY OF THE ELECTRICAL AND OPTICAL CHARACTERISTICS OF A POSITIVE GLOW-DISCHARGE COLUMN IN MOLECULAR GASES. Novgorodov, M. Z. Tr. Fiz. Inst., Akad. Nauk SSSR; 78: 60-116(1974). (In Russian).

By means of experimental methods (probe, high-frequency and optical) studies were made on electron energy distribution functions, the total concentration of electrons and band intensities in glow discharge in pure molecular gases and their mixtures with He and Xe used for $CO_2$-lasers. The effect of electron outflow to a cylindrical probe and its effect on the probe characteristics and their derivatives is considered. A method of obtaining an unperturbed distribution function is proposed. As a result of the studies it is shown that the electron energy distribution in mixtures of molecular gases is not Maxwellian. The functions which were obtained are used for calculating rates of excitation of oscillatory levels of molecules participating in the creation of an inverse population. (tr-SJR)

**19482** STUDIES OF THE PHYSICOCHEMICAL PROPERTIES OF THE PLASMA IN A $CO_2$ LASER. Ochkin, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 78: 3-59(1974). (In Russian).

Studies were carried out on the dissociation of $CO_2$ in the gas-discharge plasma of a $CO_2$ laser by following the absorption in the infrared region of the spectrum. It was established that the degree of dissociation of carbon dioxide in flow-through $CO_2$ lasers turns out to be significant even in cases of relatively fast

pumping through the working region, and attains 60% and more. A calculation of the density of oscillatory inversion is carried out with dissociation being taken into account, and it is shown that for flow-through systems the inversion density is quite inhomogeneous along the length of the discharge tube in view of the inhomogeneity of the chemical composition of the plasma. In the case of sealed systems both the electrode material and the treatment conditions of the electrodes play a great role. Processes are isolated that determine the service time of a sealed, $CO_2$ laser. A method is proposed, and measurements of oscillatory temperatures are carried out in the gases $N_2$, $N_2-CO_2$ and $N_2-CO_2-He$ in the ground electronic states according to relative intensities in the second positive system of nitrogen. (tr-SJR)

**19483** STIMULATED EMISSION FROM NUCLEI. Byrne, J.; Peters, G.I.; Allen, L. (University of Sussex, School of Mathematical & Physical Sciences). Appl. Opt. 13: No. 11, 2499-2504 (Nov 1974).

The feasibility of obtaining stimulated emission of both zero- and finite-mass particles from nuclei is considered, and the limitations imposed on the relevant nuclear parameters are determined. (auth)

**19484** HOLOGRAPHIC RUBY LASER WITH LONG COHERENCE AND PRECISE TIMING. Young, M. (Natural Science Division, Verrazzano College, Saratoga Springs, New York 12866); Hicks, A. Appl. Opt. 13: No. 11, 2486-2488 (Nov 1974).

In this paper we report the development of a holographic ruby laser with a fringe-free coherence length of over 1 m. The laser is electrooptically Q-switched for precise timing or for double-pulse operation. Oscillation is rigorously limited to a single axial mode with both a three-surface resonant reflector and a flowing-dye solution. Incorporation of the dye into the cavity decreases the energy output by ~50%, but forces the laser to produce reliable, fringe-free holograms while relaxing the requirements on the oscillator. The oscillator's output of 12-15 mJ was increased to about 0.8 J with two 15-cm (6-in.) amplifier stages. (auth)

**19485** DEVELOPMENT AND CHARACTERIZATION OF A NOVEL RESISTIVE ELECTRODE LASER. Johns, T. W. Ithaca, New York; Cornell Univ. (1974). 150p. University Microfilms Order No. 74-27,539.

Thesis (Ph. D.).

Plasma properties of a TEA $CO_2$ laser discharge were studied and were related to theory. A continuous resistive electrode stabilization method was developed and applied to two TEA $CO_2$ lasers. A single resistively ballasted atmospheric pressure pin-to-bar discharge in various laseable gas mixtures was studied with an intensified high speed streak and framing camera and fast current probe. The discharge was shown to initiate as a glow which deteriorated to a spark after a finite time delay. The delay was determined to be proportional to a constant plus the inverse of the peak current. This dependance allowed the energy deposited in the glow portion of the discharge to increase with increased current even though the delay time for spark formation decreased. The glow to spark transition was shown to proceed via a streamer like front crossing the gap at velocities slightly below electron drift velocities. A resistive electrode discharge system was developed to provide a uniform glow type atmospheric pressure discharge for microwave study. This test cell delivered over 320mJ/cm$^3$ to atmospheric pressure He discharges containing as much as 20% $CO_2$ while maintaining a glow (no filaments visible) appearance. A 70 GHz Mach-Zehnder microwave interferometer was used to measure $n_e$ and $\nu_c$ in this cell run at 100 J/liter energy input in He and He + 10% $CO_2$ + 5% $N_2$ gas mixtures at atmospheric pressure. This showed the electron number density exceeding $10^{13}$ cm$^{-3}$ with collision frequencies exceeding $2 \times 10^{12}$ sec$^{-1}$ (the limits of this microwave technique). Simultaneous measurement of the cell's I-V characteristic showed the discharge to be mobility limited. The resistive electrode stabilization concept was then applied to two one meter TEA $CO_2$ lasers. The results of a parametric study of these lasers is reported. The parameters involved were: (1) gas mixture, (2) voltage, (3) capacitance, (4) output coupling, and (5) pressure. The performance of the lasers is compared with calculated theoretical pumping efficiencies. (Diss. Abstr. Int., B)

**19486** CALCULATION OF THE AMPLIFICATION COEFFICIENT AND INVERSION IN MOLECULAR LASERS AT HIGH PRESSURE OF THE ACTIVE MEDIUM. Churakov, V. V. Zh. Prikl. Spektrosk.; 21: No. 6, 997-1004(Dec 1974). (In Russian).

The interaction of powerful radiation and the molecular system with overlapping oscillation-rotational lines was examined. Relations were obtained characterizing the distribution of the rotational inversion and the value of the amplification coefficient. For cases of the time maintenance of the generation of an equilibrium distribution of the molecules with respect to the rotational levels, formulas were derived which make it possible to calculate some parameters of single-pulse lasers working in a regime of a modulated figure of merit. (tr-auth)

**19487** INFLUENCE OF BEAM DIVERGENCE ON POWER CHARACTERISTICS OF A CW GASDYNAMIC LASER. Brunne, M.; Milewski, J.; Stanco, J.; Zielinski, A. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 22: No. 9, 789-797 (Nov 1974).

The influence of non-zero beam divergence exerted on power characteristics of a continuous wave-gasdynamic laser (CW-GDL) is considered. A formal solution of the general problem is given together with the zero- and first-order approximative evaluations of the beam divergence influence on output power, the internal quantum efficiency, the threshold value of population inversion, the radiation energy spatial distribution and the quality factor of the CW-GDL resonator. It results from the analysis that the threshold value of the population inversion and, consequently, the minimum value of the virtual radiation power do not change greatly as compared with their limiting values given without beam divergence. The main assumption and notations are identical to those adopted previously. (auth)

**19488** ANALYTICAL DESCRIPTION OF OSCILLATIONS IN MOLECULAR FLOW LASERS. Puzewicz, Z.; Trzesowski, Z. (Inst. of Quantum Electronics; Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 22: No. 9, 775-781 (Nov 1974).

The problem of oscillations in molecular flow lasers has been formulated on the basis of rate equations. The rotational relaxation processes have been included in the one-parameter approximation. It has been shown that the output power may be expressed by means of a short analytical formula as a function of parameters with clear physical meaning. The presented approach can be applied either to the gasdynamic or fast flow lasers depending on the model assumed for pumping. (auth)

**19489** AUTOMATIC FREQUENCY CONTROL OF A SELECTIVE $CO_2$ LASER BY MEANS OF A PIEZOELECTRIC DEVICE. Antropov, E. T.; Kochetkov, Yu. A.; Ostapets, V. N.; Panov, E. I.; Podobed, V. S.; Silin-Bekchurin, I. A.; Sobolev, N. N.; Taktarov, S. G. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 19: No. 2, 59-62 (Feb 1974).

Translated from Radiotekh. Elektron.; 19: No. 2, 330-334 (Feb 1974).

A stable $CO_2$ laser is described with a diffraction grating and a piezoelectric device, which provides for sufficiently large movements of the cavity mirror, necessary for cavity tuning, while using relatively low control voltages. The output laser radiation power is ≈1 W. The frequency instability was found to be better than 3 MHz for ±1.5% fluctuations in the power level. (auth)

**19490** VIBRATIONAL NONEQUILIBRIUM IN CARBON DIOXIDE ELECTRIC DISCHARGE LASERS. Murray, E. R.; Kruger, C. H.; Mitchner, M. (Stanford Univ., CA). J. Chem. Phys.; 62: No. 2, 388-399(15 Jan 1975).

An experimental and theoretical investigation of vibrational nonequilibrium in the $CO_2$ electric discharge laser was performed. The vibrational temperature for each vibrational mode of $CO_2$ was measured under a variety of discharge conditions. Measurements indicate nonequilibrium between $\nu_1$ and $\nu_2$ can be significant. Possible causes for the apparent nonequilibrium which were theoretically examined included anomalously high gain on certain transitions which has been attributed to overlapping hot band contributions, use of different optical broadening cross sections, use of different electron-vibration excitation cross sections, and the effect of uncertainty in all V-V and V-T transfer rates. The most likely cause of the measured nonequilibrium was found to be a lack of strong coupling between the $\nu_1$ and $\nu_2$ modes. (auth)

**19491** STRUCTURE OF 100-J LASER GENERATION SPECTRUM IN ETHANOL SOLUTION OF RHODAMINE 6zh. Barikhin, B. A. Zh. Prikl. Spektrosk.; 21: No. 3, 529-532(Sep 1974). (In Russian).

The dependence of the laser generator spectrum in an ethanol solution of rhodamine 6 zh on the resonator parameters was studied. The multiwave structure was shown to be due to interference phenomena in the reflection from surfaces formed by the elements of the complex resonator. (tr-auth)

**19492** RETURNING OF THE GENERATION FREQUENCY OF ARGON LASERS WITH MAGNETIC FIELDS. Grimblatov, V. M.; Teselkin, V. V.; Chulyaeva, E. G. Zh. Prikl. Spektrosk.; 21: No. 3, 537-539(Sep 1974). (In Russian).

The effect of axial magnetic fields with an intensity of 0 to 700 Oe on the displacement of the generation frequency of one-frequency Ar lasers with radiation $\lambda = 488.0$ nm was studied. The regions of Zeeman retuning of the frequency were determined

as a function of the Ar pressure. The stability of the generation frequency was measured by the heterodyne method. The relative instability is $10^{-6}$. (tr-auth)

**19493** EFFICIENT FREQUENCY-DOUBLED SINGLE-FREQUENCY Nd:YAG LASER. Culshaw, W.; Kannelaud, J.; Peterson, J. E. (Lockheed Palo Alto Research Lab., CA). IEEE J. Quant. Electron.; QE-10: No. 2, 253-263(Feb 1974).

The design and operation of an efficient stable frequency-doubled single-frequency Nd:YAG laser providing a unidirectional harmonic output is discussed. Efficient resonant cavity designs utilizing the Nd:YAG rod as an internal focusing element were used to provide adequate $TEM_{00}$-mode volume in the rod and a small beam waist at the nonlinear crystal ($Ba_2NaNb_5O_{15}$) for optimum intracavity second-harmonic generation (SHG). Various two-component low-loss intracavity mode filters were investigated and a double Fabry–Perot (F–P) fused-quartz etalon arrangement devised to obtain single-frequency operation with relative ease. The unidirectional harmonic output geometry uses a 45° mirror which favors s-polarized laser oscillations at 1.06 $\mu$m and very effectively transmits the second harmonic p-polarized radiation. Other component designs include short-radius mirror coatings highly reflective at 1.06 and 0.53 $\mu$m, and antireflection (AR) coatings on the nonlinear crystal for both wavelengths. Relative phase differences between the fundamental and harmonic radiations are uncritical and compensable by adjusting the nonlinear crystal temperature. The techniques adopted have proven adequate and stable unidirectional single-frequency power outputs of 0.3 to 0.5 W were obtained consistently from a 5- by 50-mm Nd:YAG rod pumped effectively with 850 W with a tungsten-iodine lamp in a spherical pump cavity. (auth)

**19494** CW MODE-LOCKED SOURCE AT 0.532$\mu$. Murray, J. E. (Holobeam, Inc., Paramus, NJ); Pressley, R. J.; Boyden, J. H.; Webb, R. B. IEEE J. Quant. Electron.; QE-10: No. 2, 263-267(Feb 1974).

Using external second-harmonic generation (SHG) in $Ba_2NaNb_5O_{15}$, a second-harmonic (SH) power of 550 mW, mode locked at 453 MHz has been demonstrated. Short- and long-term stabilities of better than ±5 percent peak-to-peak variation have been obtained at up to the 400-mW level. The maximum stable SH power was limited by absorption of the SH by the $Ba_2NaNb_5O_{15}$ SHG. (auth)

**19495** HIGH-ENERGY AMPLIFIERS FOR THE LASL GLASS-LASER SYSTEM. Mace, P. N.; Tanner, R. L. (Los Alamos Scientific Lab., NM). IEEE J. Quant. Electron.; QE-10: No. 2, 267-272(Feb 1974).

Rod amplifiers of 51-mm diameter and disk amplifiers with diameters of 51 and 86 mm were designed and some units have been built for use in a four-beam high-energy glass laser at the Los Alamos Scientific Laboratory (LASL). The design goals and measured characteristics of these amplifiers are discussed. Data on self-focusing damage in both rods and disks are presented. Important characteristics of capacitor-bank design, flashlamp construction, and laser glass are discussed. Completion of the four-beam system is scheduled for early 1974. (auth)

**19496** FAR-INFRARED RADIATION ISOLATOR. Boord, W. T.; Pao, Y. H.; Phelps, F. W. Jr., Claspy, P. C. (Case Western Reserve Univ., Cleveland). IEEE J. Quant. Electron.; QE-10: No. 2, 273-279(Feb 1974).

In some $CO_2$ laser systems it is necessary to isolate the amplifier sections from reflected light, n-type InSb is shown to be the best semiconductor to use in a free electron Faraday isolator. Theoretical properties of such a device are discussed and compared with measurements made on a prototype isolator. (auth)

**19497** ASYMMETRIC UNSTABLE TRAVELING-WAVE RESONATORS. Freiberg, R. J.; Chenausky, P. P.; Buczek, C. J. (United Aircraft Research Labs., Hartford, CT). IEEE J. Quant. Electron.; QE-10: No. 2, 279-289(Feb 1974).

Experimental data pertaining to the intracavity propagation characteristics, the mode volume dissimilarity, and the fractional output coupling characteristics associated with the oppositely traveling waves in $CO_2$ asymmetric unstable ring resonators are reported. Equivalence relations are derived, extending Siegman's unstable resonator analysis to encompass asymmetric traveling-wave geometries. Optical feedback techniques to suppress the oscillation associated with one of the traveling waves are demonstrated to be an effective means of achieving unidirectional ring laser operation. (auth)

**19498** HIGH-PRESSURE ELECTRICAL CO LASER. Center, R. E. (Avco Everett Research Lab., Everett, MA). IEEE J. Quant. Electron.; QE-10: No. 2, 208-213(Feb 1974).

A description is given of the development and performance of a 20-l cryogenically cooled electric CO laser designed for pulsed operation at pressures up to 1 atm. The gas is excited by an electron-beam-sustained discharge. Output pulse energies in excess of 1 kJ have been observed with a total electrical efficiency of approximately 15%. (auth)

**19499** COLD CATHODES FOR SEALED-OFF $CO_2$ LASERS. Hochuli, U. E. (Univ. of Maryland, College Park); Sciacca, T. P., Jr. IEEE J. Quant. Electron.; QE-10: No. 2, 239-244(Feb 1974).

Cold cathodes for $CO_2$ lasers should possess a very low sputtering rate, have a minimum of negative ions in the sputtering products, and consume no oxygen. These conditions can be satisfied by selecting cathode materials from those elements of group I in the periodic table which form semiconducting oxide layers and then exposing these elements to a reducing gas mixture. Experimental results show that silver, internally oxidized silver-copper alloys, and pure copper satisfy most of these requirements in He–$CO_2$–CO–Xe gas mixtures. Infrared CO and $CO_2$ gas analysis performed on simple gas discharge tubes using such cathodes indicate that laser lives of 10,000 h can be expected. In the laboratory a 1-W sealed-off $CO_2$ laser using a gas volume of only 50 $cm^3$ had an initial power output of 0.72 W which rose to 1.1 W after 3000 h and still gave 0.7 W after 12,000 hours; the laser used an internally oxidized silver-copper alloy cathode. (auth)

**19500** IDENTIFICATION OF ABSORPTION LINES IN GASES USED TO MODULATE THE $CO_2$ LASER. Martin, J. M.; Corcoran, V. J.; Smith, W. T. (Martin Marietta Aerospace, Orlando, FL). IEEE J. Quant. Electron.; QE-10: No. 2, 191-195(Feb 1974).

The absorption lines in methyl bromide, vinyl chloride, and 1,1 difluoroethylene used to modulate the $CO_2$ laser lines have been spectroscopically observed using a spectrometer which uses the signal generated by mixing a $CO_2$ laser and a millimeter wave klystron in a gallium arsenide loaded waveguide as a source. The results indicate that Stark modulation with symmetric top molecules is not necessarily due to large first-order splittings as previously assumed and that the modulation is not linear with the applied electric field. (auth)

**19501** SOLID-STATE LASER TECHNOLOGY. Barnes, N. P.; Corcoran, V. J.; Crabbe, I. A.; Harper, L. L.; Williams, R. W.; Wragg, J. W. (Martin Marietta Aerospace, Orlando, FL). IEEE J. Quant. Electron.; QE-10: No. 2, 195-201(Feb 1974).

There exists a need for laser systems with wavelength diversity and a high energy per pulse. This may be achieved with an Nd:YAG oscillator amplifier system operated either at 1.06 or 1.33 $\mu$. Methods of obtaining oscillation at 1.33 $\mu$ by suppressing the oscillation at 1.06 $\mu$ are presented. The energy per pulse from a laser oscillator can be increased by minimizing thermal problems. One method of accomplishing this is spectral filtering of the flashlamp output. Experimental results obtained for an Nd:YAG oscillator operating at 1.33 $\mu$ with various filters are presented. The energy per pulse can be further increased by the use of a laser amplifier. The effects of the amplifier on a laser pulse are investigated analytically for both circular and Gaussian cross-section beams. This investigation includes the effects of the amplifier saturation, the temporal distortion of the output pulse, and the distortion of the output intensity profile. The analytical results are compared with an experimental Nd:YAG amplifier operating at 1.06 $\mu$. (auth)

**19502** COMPARISON OF GaAs AND CdTe CRYSTALS FOR HIGH-FREQUENCY INTRACAVITY COUPLING MODULATION OF $CO_2$ LASERS. Huang, C. C.; Pao, Y. H.; Claspy, P. C.; Phelps, F. W. Jr. (Case Western Reserve Univ., Cleveland). IEEE J. Quant. Electron.; QE-10: No. 2, 186-191(Feb 1974).

High-frequency intracavity coupling modulation of the $CO_2$ laser has recently attracted considerable interest as an efficient means of achieving wide-bandwidth modulation with low modulator drive power. In the present investigation, intracavity coupling modulation was achieved at 1 GHz. Both GaAs and CdTe crystals were investigated and an optical beat method was used to explore the operational characteristics of such systems without having to go to the expense and trouble of high-speed detectors. The modulation efficiencies at the 1-GHz modulation rate were 0.5 and 1% for GaAs and CdTe electrooptic modulators, respectively. Modulator crystal characteristics such as electrical resistivity, radiation absorption, crystal uniformity, etc., which are of critical importance for intracavity modulation, were also measured for both crystals. (auth)

**19503** REVIEW OF ULTRAVIOLET LASER PHYSICS. Rhodes, C. K. (Univ. of California, Livermore). IEEE J. Quant. Electron.; QE-10: No. 2, 153-174(Feb 1974).

A review of the status and properties of coherent sources of ultraviolet radiation is presented. This includes a wide range of developments concerning atomic and molecular systems useful for generating wavelengths below 4000 Å, as well as progress in alternative methods of ultraviolet production. Particular emphasis is placed on recent advances in molecular bound-free systems

whose operation is enhanced at high densities. It is believed that some of these systems may be scalable to sufficiently high-energy outputs to be useful in controlled fusion applications. A brief prognosis and discussion of future developments tending to the x-ray region are given. (auth)

**19504** SIMPLE HIGH-POWER LARGE-EFFICIENCY $N_2$ ULTRAVIOLET LASER. Godard, B. (Centre de Recherches de la Compagnie Generale D'Electricite, Marcoussis, France). IEEE J. Quant. Electron.; QE-10: No. 2, 147-153(Feb 1974).

The conditions for population inversion between the $C^3\Pi_u$ and $B^3\Pi_g$ levels ($\lambda$ = 3371 Å) of $N_2$ such as the excitation time and the optimum value of E/p were calculated. To meet the required conditions for a very fast population inversion, a traveling wave laser structure which is very simple is described. A study was made of the experimental curves of the laser power as a function of the following parameters: channel length, pressure, distance between electrodes, velocity matching between excitation traveling wave pulse and light, and spark gap breakdown voltage. Best results obtained to date are a peak power of 9 MW with a total efficiency of about 1% and a ratio E/p ≃ 200 V/cm·torr. (auth)

**19505** SUPERRADIANT EMISSION AT 5106, 5700, and 5782 Å IN PULSED COPPER IODIDE DISCHARGES. Weaver, L. A.; Liu, C. S.; Sucov, E. W. (Westinghouse Research Labs., Pittsburgh). IEEE J. Quant. Electron.; QE-10: No. 2, 140-147(Feb 1974).

Superradiant laser emission at 5106, 5700, and 5782 Å is reported from pulsed discharges in copper iodide vapor at temperatures near 600°C. This conclusion is supported by pulse shortening of the visible emission and a marked increase in the relative visible intensity compared to the copper resonance radiation as the critical temperature range is approached. Electrical dissociation of the copper iodide, electron impact excitation of the copper atoms, and radiation trapping of the 3248- and 3274-Å resonance lines is proposed as the principal inversion mechanisms. Below ~450°C, where insufficient copper iodide is vaporized to provide resonance trapping, the upper laser level lifetimes are ~10 ns, whereas at higher temperatures trapping is complete and the effective $^2P_{\frac{3}{2}}$ and $^2P_{\frac{1}{2}}$ lifetimes are 615 and 370 ns, respectively. The reservoir temperature at which stimulated emission is observed is in good agreement with calculations of the threshold ground-state copper densities required for resonance trapping. These experiments indicate that practical copper laser systems operating at substantially reduced temperatures can be developed provided instabilities in the copper iodide discharges can be overcome. (auth)

**19506** GENERATION OF SINGLE 1-ns PULSES AT 10.6μ WITHOUT MODE LOCKING. Smith, D. L.; Davis, D. T. (Univ. of California, Livermore). IEEE J. Quant. Electron.; No. QE-10, 2(Feb 1974).

Pulses of 1-ns duration have been generated at 10.6μ without mode locking the $CO_2$ oscillator. A scheme is described which allows generation of a single pulse or a pair of pulses with adjustable spacing between pulses. (auth)

## *Cryogenic and Superconducting Equipment and Devices*

**19507** (AED-CONF-74-435-001) SUPERCONDUCTING INDUCTIVE ENERGY STORAGE. Heinz, W.; Komarek, P. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). 1974. 4p. (In German). (CONF-741061-1). INIS.

From meeting on storage systems for secondary energy; Stuttgart, F. R. Germany (2 Oct 1974).

With abstract. Available from ZAED.

Superconducting magnet systems store energy with high density. They can thus be used as fast unloading pulsed storage devices for high instantaneous power flow, as well as slowly unloading large storage units. Whereas the application as high-current pulsed source in plasma-physics experiments and in future fusion reactors seems to be promising, the technical realization and profitableness of a superconducting large storage unit with an energy storing capacity of several GWh must still be considered today as uncertain. Following a few principal considerations, superconducting energy stores as current pulse generators and for the use in interconnected systems are discussed. Experiments with energy stores in the 100 kWs region are reported and the prospects for further development (possible parameters and technical problems of larger plants) are discussed. (GE)

**19508** DOWNWARD FREQUENCY CONVERSION AT A SELF-PUMPED SUPERCONDUCTING POINT CONTACT. Gubankov, V. N.; Likharev, K. K. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 19: No. 2, 101-107(Feb 1974).

Translated from *Radiotekh. Elektron.*; 19: No. 2, 388-394(Feb 1974).

The parameters (conversion coefficient and noise temperature) of a downward parametric converter at a superconducting point contact, using the inherent Josephson oscillation as the pump (heterodyne) oscillations, were found. (auth)

**19509** NIOBIUM FOR SUPERCONDUCTING ALTERNATING-CURRENT POWER TRANSMISSION. Garber, M.; Suenaga, M. (Brookhaven National Lab., Upton, NY). Science; 186: No. 4165, 755-756(22 Nov 1974).

It is shown that both niobium and $Nb_3Sn$ conductors can be made to exhibit adequately low losses and adequate fault current capability. And, in fact, better experimental confirmation exists concerning the ability of niobium cables to recover from fault currents than of $Nb_3Sn$ cables. (auth)

# Heat Transfer and Fluid Flow

*Refer also to abstract 21826.*

**19510** (TRG-Report-2486(R)) USE OF POTENTIAL THEORY IN THE SOLUTION OF COMPRESSIBLE FLOW PROBLEMS. Collier, W. D. (UKAEA Reactor Group, Risley). Oct 1974. 18p. Dep. NTIS (US Sales Only) $4.00. UK 50 pence.

Many physical phenomena are described by potential theory and closely allied equations, including non-viscous irrotational incompressible flow. A description is given of how potential theory may be extended to compressible flow and examples of its use are provided. (auth)

**19511** (UCRL-76472) COMPUTATION OF SOLUTIONS FOR THE FLOW OF FLUIDS THROUGH POROUS MATERIALS. Pitts, J. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. 8p. (CONF-741001-50). Dep. NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

Numerical solutions to the partial differential equations covering (1) the flow of an ideal gas, and (2) the flow of a steam and air mixture, through porous materials are presented. Results are applicable to containment problems associated with underground nuclear testing, accident analysis for nuclear power generating stations, and the stimulation of petroleum reservoirs. In each case active fluid is applied under pressure to a boundary of a porous solid (earth) and pressure, temperature, and water saturation are calculated as a function of space and time. Flow rates and the location of the active fluid front are also calculated. An explicit differencing scheme is used with either a constant or time varying fluid driving pressure. Dimensionless parameters are incorporated which enhance the universality of the solutions so that results are applicable to any permeability, porosity, or length. If the driving pressure is constant, a similarity solution exists which permits extension in time and space without further computation. Both one and two-dimensional calculations are presented for the ideal gas case. Results for a steam and air mixture in a one-dimensional Cartesian coordinate system are used to examine the effects of condensation. (auth)

**19512** HEAT TRANSFER OF A FLAT ELEMENT IN A DYNAMIC TWO-PHASE LAYER. Khoze, A. N.; Burdukov, A. P.; Pokusaev, B. G.; Kuz'min, V. A. (Inst. of Thermophysics, Novosibirsk, USSR). Inzh.-Fiz. Zh.; 27: No. 5, 773-775 (Nov 1974). (In Russian).

Local mass transfer coefficients between gas-liquid flow and a vertical plate were investigated by the electromechanical method. A correlating relationship is presented which satisfactorily generalizes experimental data. The experiments make it possible to distinguish pure local transfer coefficients that have not been distorted by the effects of the edges of the meter. It was found that mass transfer is not affected by the edge effects. (auth)

**19513** APPLICATION OF QUASILINEARIZATION IN LAMINAR FREE CONVECTION ON VERTICAL PLANE. Darwish, M. A.; Elsayed, M. M. (Atomic Energy Authority, Cairo (Egypt). Reactor Dept.). Atomkernenergie; 24: No. 1, 15-19(1974).

The analytical study of the heat transfer coefficient by natural convection with the similarity method requires the transformation of the governing equations which are partial differential equations into ordinary differential equations. No straight forward or convenient method to solve these equations even by numerical methods exists because of nonlinearity and missing of initial conditions. A straight-forward method, quasilinearization, for solving nonlinear differential equations of boundary value problems developed by Bellman and Kalaba is applied here to determine the temperature distribution and the velocity induced by it. This is a prerequisite to determine the heat transfer and fluid flow parameters. Physical background of the natural

convection problem on vertical surface, application of the quasi-linearization method, and calculated results obtained are presented. A comparison between these results and those obtained by the tedious, computation time consuming method of Ostrach is also presented and shows excellent agreement. (auth)

**19514** HEAT EXCHANGER HAVING A HEAD WITH AN INTEGRAL RADIATION SHIELD. Sturiale, L. A.; Waszink, R. P. (to Westinghouse Electric Corp.). US Patent 3,857,442. 31 Dec 1974. Filed date 12 Apr 1971. 6p.

A heat exchanger having a radiation shield integral with the head and having a removable downcomer for providing access to stationary and floating head tube sheets by a remote control device when the downcomer is removed from the heat exchanger is described. (Official Gazette)

## Materials Testing

*Refer also to abstracts 19473, 20193, 20249, 20258, 20326, and 21292.*

**19515** (BNWL-787) INFRARED TESTING OF BONDS ON NIOBIUM CARBIDE COATED GRAPHITE SUPPORT BLOCKS. Day, C. K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1968. Contract AT(45-1)-1830. 67p. Dep. NTIS $6.50.

Declassified 28 Aug 1973.

Results of a research program devoted to exploratory investigations of an infrared method for detection of unbonds between graphite and niobium carbide coatings are reported. Application of a special digital dual-scan infrared technique makes the test results independent of sample surface emittance (often called emissivity). In addition this method does not require contact with the sample, and can be automated for production testing. Heat was applied to the NbC-coated graphite by projecting a hot jet of helium gas onto the surface. A commercial radiometer was used to detect the resulting surface temperatures. The theory, equipment, and experimental results from tests on niobium carbide coated, graphite support blocks are described. The results indicate that unbonds were detected with this infrared technique and that the test results were also dependent on graphite porosity. (auth)

**19516** NEUTRON RADIOGRAPHIC MEASUREMENTS USING NEUTRON DIFFRACTOMETER KSN-2. Vratislav, S. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 113-120(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

A brief survey is presented of the methods of neutron radiographic measurements using powder samples and $MnFe_2O_4$ single crystals, of texture measurements of cold rolled Zr plates and of the results obtained. (auth)

**19517** NEUTRON RADIOGRAPHY AS A NON-DESTRUCTIVE TOOL IN ARCHAEOLOGY. Robertson, T. J. M. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Non-Destruct. Test. (Guildford, Engl.); 8: No. 1, 17-20(Feb 1975).

It is shown that neutron radiography can be used with advantage to obtain more information about archaeological specimens than can be gained from x-ray techniques. Specific examples are quoted to illustrate three of the main properties of neutron beams for this work, i.e., penetration through metals, particularly durable artifacts of lead or lead-bronze materials; sensitivity to hydrocarbons of all kinds; and sensitivity to common materials like water or oil when used as contrast agents to determine methods of manufacture. (auth)

**19518** RADIOGRAPHIC TESTING OF WELDS ON SMALL DIAMETER PIPES USING YTTERBIUM-169. Dobrowolski, M.; Jedrzejewski, A. (Inst. of Nuclear Research, Warsaw). Brit. J. Non-Destruct. Test.; 17: No. 1, 15-20(Jan 1975).

New isotope containers have been developed for 360° and double-wall radiography of welds in small bore pipe up to 15 mm/0.6" diameter, incorporating low energy $^{169}Yb$ sources. These sources which are only 1 mm × 1 mm in size have been used for the inspection of nuclear reactor pipe systems. It is stated that the radiation characteristics of this source and the container design permit work in geometrically tight surroundings, and the radiation precautions need not be elaborate. Inspection sensitivities in wire image quality indicator percentages and under various geometrical conditions are quoted, as well as some typical exposure data comparing $^{169}Yb$ radiography with x- and conventional $\gamma$-ray methods. (auth)

**19519** SOME THOUGHTS ON RADIOGRAPHIC DEFINITION. Panaitescu, I. (Institut de Fizica Atomica, Bucharest). Brit. J. Non-Destruct. Test.; 17: No. 1, 1-5(Jan 1975).

Definition, as a property of a radiographic image, is a measure of the detectability of image detail. The limit of detection is set by the reduction in contrast due to unsharpness. There are two equivalent methods of studying radiographic definition: one is the Modulation Transfer Function (MTF), which represents the response of the radiographic system to a sinewave input of varying frequency, and the other is the Edge Spread Function (ESF), which represents the system's response to a step function. This paper explores the second method, showing how it can be employed, and how results can be obtained by a simple and approximate method. The discernibility of slit images and the double-bar (CERL) image quality indicator are treated as examples, showing how experimental results published elsewhere can be explained. The ESF presentation is somewhat simpler and more straightforward than the MTF for assessing radiographic definition. (auth)

## Nuclear Explosions

*Refer also to abstracts 19511, 19560, and 19673.*

**19520** (AD-774773) DEVELOPMENT OF THE GLANC EMP CODE. Longley, H. J.; Longmire, C. L. (Mission Research Corp., Santa Barbara, Calif. (USA); Los Alamos Nuclear Corp., Calif. (USA)). 10 Dec 1973. Contract DASA01-69-C-0058. 50p. NTIS $3.25.

GLANC is a computer code for obtaining the solution, by finite difference methods, of Maxwell's equations in one space dimension and retarded time, for the electromagnetic fields near the ground-air interface which are produced by a nuclear burst near or on the ground. It is a versatile code with the major new innovation being the treatment of the source in a self-consistent manner by the injection of sample Compton electrons. (GRA)

**19521** (AD-781278) BULK TURBULENCE EQUATIONS FOR FIREBALL MODELING. Releasable Memorandum, 1 April 1973-1 February 1974. King, H. H.; Eschenroeder, A. Q. (General Research Corp., Santa Barbara, Calif. (USA)). Feb 1974. Contract DNA001-73-C-0192. 39p. (GRC-RM-1881). NTIS $3.25.

Under the assumption that fireball turbulence is homogeneous, relationships are derived to allow the calculation of velocity, enthalpy, and electron density fluctuations. Electron statistics are related to enthalpy statistics through thermochemical equilibrium calculations and the construction of probability density functions. The autocorrelation function for electron density is related to that of the enthalpy fluctuations. A numerical procedure is developed for obtaining electron density profiles derived from an enthalpy fluctuation field having a specified autocorrelation. (auth)

**19522** (AD-784793) ENVIRONMENTAL EFFECTS OF HARD PAN I TEST SERIES. Final Report, April-June 1974. Rowland, R.; Gould, K.; Wooten, R.; Sigler, J.; Compton, D. (Air Force Weapons Lab., Kirtland AFB, N. Mex. (USA)). Jul 1974. 158p. (AFWL-TR-74-202). NTIS $5.00.

The environmental effects of the proposed administrative action named Hard Pan I, a Department of Defense series of high-explosive field tests (events) to simulate the shock effects of nuclear weapons on scaled Minuteman launch facilities in a specific geology were investigated. The proposed test site is a rural area of Linn County in east-central Kansas, approximately 62 miles south of Kansas City. It is planned to begin construction in July 1974 and to execute the three events in September 1974, November 1974, and June 1975. There should be no significant adverse impact on the natural or socioeconomic environment due to the construction, operations, and execution of the proposed tests. (auth)

**19523** (AD-785377) SEISMIC DISCRIMINATION. Semiannual Technical Summary Report, 1 January-30 June 1974. Chinnery, M. A. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 30 Jun 1974. Contract F19628-73-C-0002. 72p. (ESD-TR-74-221). NTIS $3.75.

The following topics are discussed: international seismic month, data management, earthquake source mechanisms, focal depth, surface-wave studies, earth heterogeneity, and general seismology. (GRA)

**19524** (FOA-C-20027-T1) ESTIMATION OF FOCAL DEPTH BY pP AND sP PHASES. Yamamoto, M. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Dec 1974. 35p. Dep. NTIS (US Sales Only) $4.75.

There are several methods to discriminate between underground nuclear explosions and natural earthquakes on seismic records. It has been observed, however, that the recordings of deep focus earthquakes frequently appear quite explosion-like. Effective methods to estimate the focal depth will thus play a significant role in identifying underground nuclear explosions. The accurate depth estimate of earthquakes is also important for the geophysical interpretation of local and global seismicity. A method to estimate the focal depth of seismic events is discussed. This method is based on reflected phases like pP and sP of the primary P wave and the main objective is to outline the problems of utility. (auth)

**19525** (UCRL-74841) CASE STUDY OF A REGIONAL GAS SUPPLY. Holzer, F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1973. 9p. (CONF-731101-58). Dep. NTIS $4.00.

From joint meeting of the American Nuclear Society and the Atomic Industrial Forum and Nuclear Energy Exhibition; San Francisco, California, USA (11 Nov 1973).

The present study was undertaken to evaluate to what extent nuclear gas stimulation could supply additional gas for home and industrial heating. More specifically, it examines to what extent a rather modest development program could contribute to a local or regional supply, while at the same time permit technology to be refined and the public to gain confidence in this technique. If successful, such a program could form a basis for future decisions on a more extensive exploitation of the technique. By using projected gas demands for a defined region—in this case for the State of Colorado—specific examples of nuclear gas well developments can be worked out, and their economic and environmental consequences examined. It is shown that a relatively modest program of nuclearly-stimulated wells could supply the amount of gas used for domestic and industrial purposes in Colorado. The associated benefits to consumers as well as to all levels of government—local, state and federal—could be substantial. Public inconvenience can be minimized by developing and applying sequential explosives. While there would be some residual radioactivity in the gas, the resultant dose to individuals would amount to a fraction of a percent of the natural background level. (TFD)

**19526** (UCRL-76469) DOWNHOLE SYSTEMS DESIGN. McKay, J. P.; Depta, J. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. 8p. (CONF-741001-48). Dep. NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

Effects experiments in vertical configurations require large "line-of-sight" pipe systems. These systems must be designed to survive both severe and complex loading conditions and at the same time must not exceed the capacity of the usually available emplacement equipment (750,000 lbs.). Optimization of the system was achieved through computer aided design. Computer programs PIPDES1, PIPDES2 and DAPTA were written to produce the desired automation from analysis to the finished assembly drawings. PIPDES1 performs a preliminary design, taking the required flux diameter at an experiment station, its distance from the WP, the diameter of the bottom pipe spool, casing or hole diameter, emplacement depth, pipe, flange and bolt yield strengths, soil Poisson's ratio, soil shock transmission properties, factors of safety, and designs a LOS pipe system of minimum weight. PIPDES2 is much more detailed. It is intended for the final design phase of an experiment. Both versions perform the detailed design of rib-stiffened flanges and pipe thickness together with external stiffening rings, calculate stemming loads, weights and all pertinent stresses in the environment. (auth)

**19527** (UCRL-76470) LINE-OF-SIGHT (LOS) PIPE FLOW CALCULATIONS. McCauley, E. W.; Sutton, S. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. 8p. (CONF-741001-47). Dep. NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

Modern day testing of nuclear explosives is conducted at great depths underground in order to provide for zero radioactivity release to the environment. A common class of these tests requires a significant length of open pipe (LOS) above the working point. Definition of the dynamic environment to which hardware, provided to dispel this potential leak path, is exposed is a vital part of the safety assessment procedures preliminary to any successful experiment. The quasi-one-dimensional Lagrangian code FLIPRZ, operating on the CDC-7600 computers of LLL, provides this assessment. Pipe flow, with input derived from two-dimensional Eulerian calculations completed at times a few hundred microseconds after detonation is traced by FLIPRZ to provide a comprehensive estimate of the plasma flow phenomena and environment in the LOS pipe and its effect on related system hardware. (auth)

**19528** INDEPENDENCE AND DETERRENCE. Britain and Atomic Energy, 1945–1952. Volume I. Policy Making. Gowing, M.; Arnold, L. London; Macmillan (1974). 515p.

The subject is covered in chapters, as follows: August 1945, retrospect and agenda; Labour's machinery of government: 1945 to 47, external policy (three chapters entitled: brief hope of interdependence, hopes are dupes (international control, Anglo-American collaboration), the Commonwealth and Europe); deterrence; 1947 to 51, deterrence recalculated; the Anglo-American modus vivendi; independence reconsidered (two chapters); the area of interdependence—uranium (supplies); "Winston is back"—and Cherwell. (UK)

**19529** INDEPENDENCE AND DETERRENCE. Britain and Atomic Energy, 1945–1952. Volume II. Policy Execution. Gowing, M.; Arnold, L. London; Macmillan (1974). 570p.

The subject is covered in chapters, as follows: part 1 (the framework); the men; resources; health and safety security; the role of private industry and government agencies: part 2 (the enterprise); research—Harwell's role; nuclear power-feasibility studies; radioisotopes; the factories [for producing Pu and U235]—programmes and methods; the individual factories; the weapon; Monte Bello; epilogue. (UK)

## Protective Structures and Equipment

*Refer also to abstract 21776.*

## Safety Engineering

*Refer also to abstracts 19999 and 20000.*

**19530** (INIS-mf-1278) INDUSTRIAL SECURITY PROGRAMMING AT THE NUCLEAR CENTER OF MEXICO. Martinez P, M. E. (Instituto Tecnologico Regional de Veracruz (Mexico)). 1973. 71p. (In Spanish). INIS.

Thesis.

The safety conditions and necessities existing in each work area of the Centro Nuclear de Mexico were determined in order to ascertain if the programming of safety activities cover adequately the need. The installations were inspected to determine safety conditions in the work, machining and equipment, electrical installations, handling of materials, necessity of personal protection equipment, and prevention of fires. The accidents occurring during the observation period were of the industrial type such as cutting of the arms, splattering chemicals in the eyes, bruises in different parts of the body, and scalds. Accidents during the handling of radioactive material were infrequent. From the safety statistics given it is inferred that the greater part of the accidents are caused by personal negligence, usually the personnel of the machine shops and the laboratories. Most accidents occur on those days with the maximum work efficiency. Therefore, it is necessary to educate the worker in his labor habits in order to create a safety consciousness. (tr-auth)

**19531** (IRS-T-26) EXPLOSION OF JUNE 1, 1974, IN THE CHEMICAL PLANT OF THE FIRM NYPRO LTD. IN FLIXBOROUGH, SCUNTHORPE, ENGLAND. Alex, H.; Jungclaus, D. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). Nov 1974. 32p. (In German). Dep. NTIS (US Sales Only) $4.75.

Impressions and information are presented following a visit to the place of accident. Pictures show the extent of structure damage. Newspaper articles are also included. From the available information, it may be concluded that nuclear power plants were not endangered by this incident, if minimum distances proposed by the IRS are followed. (auth)

**19532** (SRD-R-8) CHEMICAL PLANTS AND LABORATORIES: SAFETY ASSESSMENT. Fairbairn, A.; London, E. S.; Lockett, L. E.; Cook, A. (UKAEA Safety and Reliability Directorate, Culcheth). 1974. 74p. Dep. NTIS (US Sales Only) $6.75.

The nature and degree of hazards associated with many of the UKAEA's chemical plants and laboratories are of significance both to persons employed on the site and to the general public. For such facilities it is necessary to ensure that the significant hazards have been identified, and that adequate safeguards have been provided in respect of persons who may be at risk. Guidance is given on the requisite safety assessment work. This comprises three stages: advice to the designer during design study on the formulation of safety principles and on their application during subsequent detailed design also preparation of the design safety document; formal safety assessment of design and preparation of the operation safety document; and safety assessment of operations. (UK)

# Vacuum Engineering

**19533** VACUUM FACILITY WITH A TITANIUM PUMP.
Ponomarev, V. P. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 38-43(1973). (In Russian).

The construction characteristics are given for a vacuum facility designed for evacuation and preliminary processing of instruments during their fabrication. The vacuum facility is equipped with a Ti ion-sorption pump. The vacuum attainable is $1 \times 10^{-7}$ to $7 \times 10^{-8}$ Torr. The basic characteristics of the pump are given. The vacuum facility is used for the evacuation of two glass chambers for a miniature betatron. (tr-auth)

# ENVIRONMENTAL AND EARTH SCIENCES

## Minerals and Ores

*Refer also to abstracts 19615, 19712, and 20077.*

**19534** (NP-20304) MAGNETIC EXPLORATION AS A GUIDE IN LOCATING URANIUM. Ruiz Reyes, J. A. (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria). 1974. 75p. (In Spanish). Dep. NTIS (US Sales Only) $6.75.

Thesis.

The genesis and characteristics of U deposits and their magnetic characteristics in different types of rocks are briefly outlined. The application of the magnetic method to the initial exploration for U deposits in the area to the south of the town of Mier in Tamaulipas is described in detail. It is concluded that magnetic exploration is useful in detecting areas with possible uranium mineralizations. (JSR)

**19535** (NYO-9605) INVESTIGATION OF THE MINERALOGY AND PETROGRAPHY OF URANIUM-BEARING SHALES. Final Report. (Pennsylvania State Univ., University Park (USA). Dept. of Mineralogy and Petrography). 25 Aug 1961. Contract AT(30-1)-1202. 53p. Dep. NTIS $5.45.

A summary is presented on ten years of research work on the mineralogy, petrology, and chemistry of Chattanooga and other black shales, of particular interest because of significant concentrations of uranium. Certain clearly established conclusions are discussed. It is suggested that the uranium present was precipitated under reducing conditions in mud that was eventually consolidated into rock. Since the intensity of the reducing conditions depended upon the ability of organic matter to remove available oxygen, there is a high degree of association between uranium and carbon, a relationship that is not completely understood. It is concluded that the amount of uranium available, the redox potential, the amount of diluting sediment (either authigenic or detrital) and the rate of accumulation appear to be the controlling factors in the systems investigated. With the exception of the secondary meta-autunite in the St. Hippolyte samples, no uranium minerals were found in the black shales investigated. Nuclear track and chemical leaching studies indicate that the element occurs disseminated throughout the fine-grained organic-clay-pyrite matrix or in occasional concentrations in organic bodies with associated pyrite and other mineral matter. It appears likely, that differences in amount of uranium such as that exemplified by the Chattanooga (0.0053%) versus the Alum (0.0254%) shales are in part due to the concentration of uranium in seawater, the land-locked basins containing a higher concentration than those of the more open seas. (JGB)

**19536** (ORNL-tr-2892) MINERAGRAPHY OF THE URANIUM ORES OF OKLO DEPOSIT (GABON). Geffroy, J.; Lissillour, J. Translated by M. Gerrard, Oak Ridge National Lab., TN, from Bull. Inform. Sci. Tech. (Paris); No. 193, 51-58(Jun 1974). 11p. Dep. NTIS $4.00.

At Oklo, two types of ores can be distinguished: types with carbonaceous matter, observable in the sandstone or conglomeratic rocks (dissemination of pitchblende with sometimes cofinite, in a polymerized asphaltic material) and types with uraninite (euhedral $UO_2$), often massive, in a clay mineral matrix with dominant chlorite. The whole is intersected or scattered in microbreccia by galena, with almost entirely radiogenic lead. The deficiencies in $^{235}U$ were observed only in this second type of ores. Nevertheless, no difference from mineralogical viewpoint is observable between normal uraninite ores, and those from Oklo with modified isotopic spectra. In these particularly, no evidence of thermal or mechanical modification have been recorded. (auth)

**19537** (ORNL-tr-2895) ISOTOPIC ANALYSIS OF RARE EARTHS IN OKLO FOSSIL REACTOR MINERAL. Neuilly, M.; Dozol, J. F. Translated by R. G. Mansfield, Oak Ridge National Lab., TN, from Bull. Inform. Sci. Tech. (Paris); No. 193, 77-81 (Jun 1974). 6p. Dep. NTIS $4.00.

Subsequent to the finding of a fossil reactor at Oklo, as indicated by isotopic analyses of the uranium, which is depleted in $^{235}U$, and the neodymium, whose isotopic composition is very different from the natural composition, systematic samplings were made on the site. Results obtained on a series of samples taken at the surface are presented. Mass spectrometric data are presented for Nd, Sm, and Eu isotopes. (MCG)

**19538** (RME-2049) SOME URANIUM DEPOSITS ASSOCIATED WITH VOLCANIC ROCKS, WESTERN UNITED STATES. Waters, A. C. (Johns Hopkins Univ., Baltimore, Md. (USA)). 28 Nov 1955. 20p. Dep. NTIS $4.00.

The report consists of two parts. In the first part, an attempt is made to analyze and classify uranium-bearing deposits associated with volcanic rocks into genetic types, and to outline the probable conditions under which they were deposited. The second part lists the individual properties visited and describes briefly a few of their salient geologic features. Four hypotheses, each emphasizing a different possible relationship between uranium deposition and volcanic activity, are briefly discussed. (ERB)

**19539** REINTERPRETATION OF THE GEOLOGY OF THE ALLIGATOR RIVERS URANIUM FIELD, N. T. Needham, R. S. (Bureau of Mineral Resources, Canberra); Smart, P. G.; Watchman, A. L. Search; 5: No. 8, 397-399(Aug 1974).

Early reconnaissance mapping of "Archaean basement" rocks east of Darwin has been superseded by more detailed (1 : 100,000 scale) mapping. These rocks now appear to be metamorphic equivalents of Lower Proterozoic sedimentary units exposed further south in the El Sherana district. The clear spatial relationship with uranium mineralization shown at El Sherana can now be traced north into the metamorphic terrain of the Alligator Rivers region. The latter region, east of the South Alligator River, is dominated by two large migmatite complexes formed during an intense phase of regional metamorphism at the end of Lower Proterozoic times (preliminary geochronology results indicate a date of 1800 m.y. for regional metamorphism and migmatization). This metamorphic terrain, here referred to as the Alligator Rivers Uranium Field, is potentially one of the world's greatest sources of uranium; its northern and eastern extents are concealed by younger strata. (auth)

**19540** RECENT DISCOVERY OF A PREHISTORIC REACTOR IN GABON. Bussac, J. (CEN de Saclay, Gif-sur-Yvette, France). pp 1183-1189 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

Recent work by the French Atomic Energy Commission after the discovery in the Oklo mine batches of tons of uranium containing 0.62 or 0.64 of $^{235}U$ is reviewed. These anomalies in the isotope ratios have been explained as due to a self-sustained chain reaction, that is to say a real fossil reactor. (FR)

**19541** $^{234}U$ AND $^{238}U$ IN THE CARRIZO SANDSTONE AQUIFER OF SOUTH TEXAS. Cowart, J. B. Tallahassee; Florida State Univ. (1974). 88p. University Microfilms Order No. 75-950.

Thesis (Ph. D.).

The waters of the Carrizo Sand formation of South Texas, USA, exhibit a pattern of uranium isotopic disequilibrium, described in terms of $^{234}U/^{238}U$ activity ratio ("A.R.") and uranium concentration, which may be a function of geochemical factors and the hydrologic history of the area. In terms of uranium, two regimes seem to exist. The first, including outcrop and near outcrop sample locations, has waters with relatively high concentration and low A.R. Somewhat downdip, the uranium concentration decreases sharply at the downdip limit of the oxidation environment, a zone of uranium precipitation. Recoil of daughter products from the precipitated uranium causes an increase of A.R. of the water. Water of low uranium concentration and high A.R. is found throughout the downdip regime. If a constant input of $^{234}U$ through time is assumed, the downdip decreases in A.R. after the initial introduction of $^{234}U$ into the water may be ascribed to radioactive decay of $^{234}U$. However, this assumption leads to the calculation of a water flow rate one twentieth that determined by other means. Alternatively, this pattern may be an artifact of a change of climate from 20,000 years to 10,000 years ago. In this case, the decrease in A.R. downdip is a function of a varying input of $^{234}U$ as well as decay. (Diss. Abstr. Int., B)

**19542** PORTUGUESE URANIUM DEPOSITS. Matos Dias, J. M. (Junta de Energia Nuclear, Lisbon); Sores de Andrade, A. A. Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro; No. 70, 1-22(1970).

Portugal is built up of a Hercynian basement (the western part of the Iberian Meseta) bordered by epicontinental sediments of Meso-Cenozoic age. All the uranium deposits so far known occur in the Meseta. They reveal a series of common aspects according to the scale of observation. On the regional scale they are related to Hercynian younger granites with a high background of radioactivity and outcrop in neo-Cretaceous and possibly Triassic peneplains. On the local scale they occur close to the roof or the walls of the granite bodies and are located in fractures of variable magnitudes, excluding big faults. They show a progressive disappearance with depth. On the mineralogical scale pitchblende +

pyrite (and/or marcasite) ± jasper is the commonest mineral association. Gummite, black oxides and colored secondary minerals are abundant in the upper levels. On the chemical scale, by radiometric dating, two age models are known, 80-100 million years (m. y.) and 190 ± 10 m. y. Based on these facts and after a discussion of the literature, a supergene origin is assumed for Portuguese deposits, and some guides for prospecting ore bodies in the Meseta and in border lands are examined. (auth)

**19543** URANIUM IN PORTUGAL: A GEOECONOMICAL PERSPECTIVE. Matos Dias, J. M. (Junta de Energy Nuclear, Lisbon). Publ. Museu Lab. Mineral. Geol. Univ. Coimbra Centro; No. 71, 36-47 (1971). (In Portuguese).

The role to be played by uranium as an energy resource is considered in the light of the evolution of the worldwide consumption of energy during the last decades and the changes of contributions given by the different energy types. If the uranium demand is compared with the now existing reserves, it is concluded that it is necessary to increment the search for uranium in order to expend those reserves. (auth)

**19544** THORIUM AND URANIUM DISTRIBUTION IN THE KRASNOYARSK BAUXITE DEPOSITS. Gurvich, M. Yu.; Parshakov, N. S.; Skosyreva, L. N. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 10, 38-43(Oct 1974). (In Russian).

The distribution of radioactive elements in stony bauxite is not homogeneous, the ore bodies being more radioactive than the intergranular cement. In clayey bauxites the uranium and thorium distributions are approximately the same. There is a space connection between the radioactive elements and iron oxides and hydroxides, the thorium being spatially confined chiefly to hematite and the uranium to goethite. The uranium and thorium distributions in bauxites indicate that the enrichment of bauxites in thorium occurred primarily by entrapment of thorium-containing suspensions of mineral particles on coagulation of iron-alumina gels. The uranium in bauxites is apparently related with sorption of its clayey and alumina minerals during the diagnosis of bauxite-bearing deposits. In bauxites are often found microinclusions of accessory minerals, on which both the thorium and uranium radioactivity depends. The behavior of uranium and thorium during the formation of bauxites requires further study; radiography may be used successfully along with other highly sensitive methods in study of the origin of bauxites. (tr-auth)

## Radioactive Effluents

*Refer also to abstracts 19565, 19975, 19977, 19979, 19980, 20074, 20550, 21346, 21795, and 21886.*

**19545** (74-CNA-600, pp 15) ENVIRONMENTAL MONITORING AND CONTROL OF RADIOACTIVE MATERIALS RELEASED FROM QUEBEC AND ONTARIO HYDRO NUCLEAR POWER STATIONS. Marois, H.; Wilson, R. J. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-600.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 6 Nuclear energy and the public.

Techniques and results for radionuclide monitoring in the neighbourhood of nuclear power stations in Ontario and Quebec are described. Data are given for all completed stations, namely, NPD, Douglas Point, Pickering A, and Gentilly 1. Samples monitored include air, water, precipitation, fish, milk, and vegetation. Canadian experience has shown the most important radionuclides to be cesium-137, cesium-134, iodine-131, cobalt-60, and tritium. Apart from tritium levels in air and precipitation, the levels measured are similar to the "background". Tritium levels, although elevated, are not significant in terms of radiation dose at the boundary. (INIS)

**19546** (DHEW/FDA-75-8010, pp 145-149) EPA ROLE IN NUCLEAR ENVIRONMENTAL STANDARDS. Mills, W. A. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The role of the Environmental Protection Agency in setting standards for the release of radioactivity to the environment is reviewed. (CH)

**19547** (DHEW/FDA-75-8010, pp 162-170) EPA WATER QUALITY CRITERIA AND DRINKING WATER GUIDELINES. Ellett, W. H. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Criteria for drinking water quality are discussed with emphasis on the content of radioactive materials. It is pointed out that the original source of the water supply determines to a very large extent what kind of radioactivity is likely to be present and those using ground water are more likely to have natural radioactivity while surface waters may contain artificially produced radionuclides from either run-off or effluent discharges from nuclear facilities. In either case, the primary criterion for approval is a limit on the radiation dose to the population using the water supply. The role of the Environmental Protection Agency in developing standards for drinking water quality is discussed. (CH)

**19548** (DHEW/FDA-75-8010, pp 215-233) RADIOLOGICAL ASSESSMENT OF ENVIRONMENTAL DOSES FROM LIGHT WATER REACTORS. Kastner, J. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The preparation of an Environmental Impact Statement prior to the licensing of a commercial power reactor requires the assessment of the radiological impact of the proposed facility. Detailed evaluations are presented of the impact in the public domain of releases to the environment, including pertinent exposure pathways and probable exposures of individuals and population groups, as well as organisms other than man. The method of assessment is the same for any facility; only the details are different. The prime determination is the radiation exposure to man and biota which arises from the inhalation, ingestion, and external presence of various radionuclides. Development of the radiological impact statement needs to start with the facility itself, work through the environmental and population factors operating between the points of release and the points of public exposure, and then should consider the potential radiation doses to the public. The principal pathways by which radioactive materials released to the environs can reach and expose people and biota other than man are discussed. Data on the Dresden-1 reactor are presented as an example of the radiological impact of a light water reactor. (CH)

**19549** (KFK-2035) PRODUCTION AND RELEASE OF RADIOACTIVE KRYPTON- AND XENON-ISOTOPES BY NUCLEAR POWER PLANTS AND REPROCESSING PLANTS AND THE EXPECTED RADIOLOGICAL BURDEN TILL THE YEAR 2000. Hilbert, F. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (F.R. Germany). Projekt Nukleare Sicherheit). Aug 1974. 193p. (In German). INIS.

With figs. and tabs.; 257 refs.

The natural production of radioactive krypton and xenon isotopes is summarized in this report together with the yields from nuclear facilities and nuclear weapons tests. Specific production rates in nuclear power reactors are calculated. The activity flow in the different plants are described and the consequent release rates, representative of time are evaluated. Estimated release rates from 1,500 t/a fuel reprocessing plants are also included. With the condition that a dose of 30 mrem/a should not be exceeded for any release, the requisite minimum decontamination factors and cooling times are specified. Based on the forecasted growth of nuclear facilities till the year 2000, the time dependent global concentrations and radiation doses from $^{85}Kr$ releases are calculated using different atmospheric models. The effect of noble-gas separation from the plant off-gas streams in nuclear facilities on the exposure is investigated. (auth)

**19550** SELECTION OF A GROUND DISPOSAL SITE FOR RADIOACTIVE WASTES BY MEANS OF A COMPUTER. Morisawa, S.; Inoue, Y. (Kyoto Univ.). Health Phys.; 27: No. 5, 447-457(Nov 1974).

The feasibility of disposing of radioactive wastes in the ground, the optimal conditions for the site, and the evaluation of safety factors have been reported in previous papers (Inoue and Morisawa. Health Phys.; 26: 53 (1974). Morisawa and Inoue. Health Phys.; 26: 251 (1974)). This paper discusses processes of selecting optimum locations for the disposal of radioactive wastes by means of a computer. A program for site selection is based on some reasonable assumptions and includes the data required to estimate the dose of radioactivity in the human body due to the disposed wastes of a nuclear facility along a coast. The calculations were made for a model nuclear facility that was chosen to show the general method of selecting a ground disposal site.

An optimum location for a ground disposal site is defined as a location with minimum internal dose caused by the disposed wastes. Four locations were selected using a computer, each location having a minimum internal dose based on the assumption of 0.1 Ci/yr leakage of $^{90}Sr$. The minimum internal dose for the four locations was estimated to be lower than $10^{-30}$ mrem/yr. The method of selecting optimum locations is reasonably promising for solving current problems of site selection for disposal. A chart to compare the safety of sites by evaluating each with reference to eighteen environmental factors is included. (auth)

**19551** EFFECTS ON THE ENVIRONMENT OF NUCLEAR POWER STATIONS. Wobrauschek, P. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 324-328(Jun 1974). (In German).

Consideration is given to the influence of atmospheric conditions on the dispersion of a cloud of exhaust gas emitted from the chimney of a nuclear power station. The distribution of concentration resulting through atmospheric diffusion is determined mathematically and this enables the radiation intensity and the anticipated radiation exposure dose to be evaluated. (INIS)

**19552** HAZARDS OF NUCLEAR REACTORS AS A FUNCTION OF REACTOR POWER AND DISTANCE: THE SITE ATMOSPHERIC FACTOR. Le Quinio, R. (CEN de Saclay, Gif-sur-Yvette, France). pp 83-94 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The characterization of a reactor site by a relative value representing hazards transmitted via the atmosphere is discussed. A general method is proposed, which, with a few supplementary hypotheses, can be applied to particular cases. First, on the assumption that there is an upper damage threshold, one determines, as a function of reactor power, a maximum distance from the reactor at which damage will occur by taking effluent emission together with atmospheric diffusion coefficients. In evaluating the risk for each distance, account is taken of atmospheric diffusion and the probability of an accident of a certain severity. The population inside the circle of maximum radius is then weighted, both as a function of the previously obtained distance factor and as a function of the prevailing wind directions. The practical application of the method is discussed in the light of the accuracy of the currently available data. A numerical example is given. (auth)

**19553** EXPERIENCE GAINED IN APPLYING THE ICRP CRITICAL GROUP CONCEPT TO THE ASSESSMENT OF PUBLIC RADIATION EXPOSURE IN CONTROL OF LIQUID RADIOACTIVE WASTE DISPOSAL. Preston, A.; Mitchell, N. T.; Jefferies, D. F. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). pp 131-146 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The control of liquid radioactive waste disposal to the aquatic environment of the United Kingdom is based on the limitation of public radiation exposure. Experience has shown that in general somatic dose has been of greater importance than genetically significant exposure. UK waste disposal policy is briefly reviewed, showing the importance attached to the estimation of radiation exposure of the individual or of small groups of the population in a somatic context. Control of such exposure has been based on critical pathway analysis, and originally on the most highly exposed individual isolated from a representative sample of the exposed population; latterly the critical group concept has been used as outlined in the current recommendations of the ICRP. The problems of applying this concept, together with its advantages and disadvantages, are discussed. The paper goes on to review experience gained in attempting its application. It concludes with a comparison, using the two most important internal exposure pathways for Windscale sea discharges (Porphyra/laverbread and fish), of different methods of critical group identification which have been examined. (auth)

**19554** DERIVATION OF WORKING LIMITS FOR THE CONTROLLED DISCHARGE OF RADIOACTIVE WASTES FROM NUCLEAR INSTALLATIONS. Subbaratnam, T.; Soman, S. D. (Bhabha Atomic Research Centre, Bombay). pp 329-336 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The policy and methodology adopted in India for the routine control of liquid and gaseous radioactive wastes are outlined and the factors and considerations used in applying ICRP recommended dose limits to the establishment of derived working limits for the controlled releases of radioactive effluents to the environment are described. Specific examples of the methods used in obtaining derived working limits are given. The impact of such controlled releases on the radiation dose to the population is discussed. (auth)

**19555** EVALUATION OF THE RESUSPENSION PATHWAY TOWARD PROTECTIVE GUIDELINES FOR SOIL CONTAMINATION WITH RADIOACTIVITY. Anspaugh, L. R.; Shinn, J. H.; Wilson, D. W. (Univ. of California, Livermore). pp 513-524 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The resuspension and subsequent inhalation of surface-deposited radioactivity released to the environment can be a significant mode of exposure for a few radionuclides such as $^{239}Pu$. Two simple, interim models, which may be used to predict the average concentration of resuspended aerosols, are developed on an empirical basis. One method uses the time-dependent resuspension factor approach, and differs from previous work in placing more emphasis on resuspension at late times. The second method is appropriate only for aged sources and uses a straight-forward mass-loading approach. The relative significance of the resuspension pathway is also modelled in comparison to the initial exposure resulting from a non-nuclear explosion that disperses radioactivity. Two hypothetical $^{239}Pu$ contamination situations are modelled. In the first case the 50-a dose commitment resulting from an initial deposition of 1 $\mu Ci/m^2$ is calculated as a function of time post deposition. Half of the total dose commitment is accumulated in the first 100 d. In the second situation the reoccupation of an area contaminated many years previously is considered. Protective guidelines for $^{239}Pu$ soil contamination are derived from these studies—1 $\mu Ci/m^2$ for a freshly deposited source and 7 nCi/g in the top 10 mm of soil for a source that has aged several years. An estimate of the biological cost of not cleaning up contaminated areas is compared with the engineering and agricultural costs of soil removal. (auth)

**19556** BASIC PRINCIPLES FOR THE LIMITATION OF RELEASES OF RADIOACTIVE SUBSTANCES FROM NUCLEAR POWER STATIONS. A Joint Statement from the Radiation Protection Institutes in Denmark, Finland, Iceland, Norway, and Sweden. Oslo; Staten Institutt for Straalehygiene (1974). 23p.

This publication is a preprint of Chapter 19 of: "The applicability of current international radiation protection recommendations in the Nordic countries."

The possibility of large numbers of power reactors all over the world by the beginning of next century necessitates careful planning and stringent release limitation. It is therefore necessary to introduce a system of release limitation derived not only from the ICRP dose limits for individuals but also from consideration of population exposures. The Nordic countries' Radiation Protection Institutes have therefore formulated recommendations based on the following three requirements, (a) the doses to the critical group, as defined by ICRP, shall not exceed a stipulated fraction of the general dose limits to individual members of the population at large; (b) the collective dose to the whole world population shall not exceed a certain value, related to the installed nuclear power, low enough to guarantee that the average annual dose from this source at the time when power stations now being planned are replaced by new ones will be only a small fraction of the annual dose from natural radiation sources; and (c) the design, installation and operation of equipment, and methods for the purpose of further limiting the release of radioactive substances shall be as efficient and extensive as reasonably achieveable in the spirit of the relevant recommendations of ICRP. (NO)

**19557** INFLUENCE OF COASTLINE METEOROLOGICAL CONDITIONS ON ATMOSPHERIC DIFFUSION OF GASEOUS EFFLUENTS. De Cecco, G.; Guidici, G. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz.; 17: No. 1, 7-17(1973). (In Italian).

The problem of atmospheric diffusion at coastal sites is discussed with particular reference to the influence on local meteorological conditions due to the presence of large water bodies as oceans and large lakes. Land and sea breezes theory is briefly outlined in order to describe the main effects that these local winds could have on atmospheric diffusion. The most important of them is the possibility of occurrence of the sea breeze fumigation phenomenon. As an example, the implications of a short release of gaseous effluents from a nuclear ship moored near the coastline are discussed. In this case the area involved with the maximum values of the ground level concentrations is defined. (auth)

## Radioactivity Monitoring and Transport

*Refer also to abstracts 19545, 19552, 19677, 19678, 19731, 19951, 19975, 19983, 19984, 20079, and 20080.*

**19558** (AECL-5018) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, JULY 1–SEPTEMBER 30, 1974. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nov 1974. 67p. (PR-B-103). Dep. NTIS (US Sales Only) $6.50. AECL $1.50.

Separate abstracts were prepared for four sections of this report. (CH)

*For abstracts of individual sections see: 19559, 19719, 19858, and 20032.*

**19559** (AECL-5018, pp 23–42) ENVIRONMENTAL RESEARCH BRANCH. Ophel, I. L. Nov 1974.

In Biology and Health Physics Division Progress report, July 1–September 30, 1974.

Results of routine monitoring of radioactivity in environmental samples from the vicinity of CRNL, liquid effluents, the liquid disposal area, and measurements of the γ dose rate at the site boundary are reported. Studies were conducted on the growth and feeding behavior of smallmouth bass fry confined to the heated water zone (15°C above ambient) of experimental columns in Maskinonge Lake. No growth differences between control and experimental fish were observed. A comparison of $^{60}Co$ and $^{90}Sr$ distribution in Perch Lake sediments shows that the radiocobalt is confined to the top few centimeters whereas $^{90}Sr$ has penetrated to considerably greater depths. The difference is tentatively attributed to differences in binding of the two radionuclides by organic constituents of the bottom sediment. A new point dilution apparatus was constructed and used for the measurement of ground water movements in Perch Lake drainage basin. The new equipment appears to give a more accurate (higher) estimate of water velocity in specific soil layers. A series of dilution tests was carried out in the St. Lawrence River at Gentilly using Rhodamine B dye. The results indicate a very poor dilution regime in the inshore region of the river at that location. A study of tritium concentrations in the bound and free water of vegetation near the CRNL Waste Management Area indicates wide differences at different times and places. The available evidence indicates that these variations reflect changing concentration conditions in the waters of the area and are not attributed to isotopic discrimination by plants. (CH)

**19560** (COO-3015-13) SCALE FACTORS FOR FOLIAR CONTAMINATION BY STRATOSPHERIC SOURCES OF FISSION PRODUCTS IN THE NEW ENGLAND AREA. Russell, I. J.; Choquette, C. E. (Boston Coll., Chestnut Hill, Mass. (USA). Dept. of Chemistry). 1 Sep 1974. Contract AT(11-1)-3015. 49p. Dep. NTIS $5.50.

Concentrations of fission product radionuclides from well spaced Chinese nuclear explosions in the megaton range have been measured in conifer and deciduous leaf trees in the New England area from 1968 to 1974. Radionuclide concentrations per unit area of leaf are obtained by high resolution gamma ray spectroscopy of compressed pellets of leaf ash of oak, maple, white pine, gingko, beech, birch, and selected additional species. Dividing by total source strengths gave the fractional source strength per unit area of leaf. Sequential samplings of leaves throughout the spring and summer months reveal that an apparent steady state in leaf concentration is achieved by mid to late June. A rapid acquisition is noted during the first month of leaf life of deciduous species depending upon the cycle of rainy and dry periods. By mid June the quasi-steady state concentration is reached, with a slowly declining inventory for the remainder of the summer. The kinetic data are inconsistent with a simple first order acquisition and loss process; initial growth takes place with a half time of about three days and the decline with a half time of 50 to 200 days, depending upon leaf species. Evidence is presented that a static state and not a dynamic equilibrium obtains in mid to late summer months. The peak concentration in the leaf is proportional to surface particulate or rain radionuclide concentrations. The peak value of $^{141}Ce$ in the leaf and relative concentrations of other fission products and of $^{7}Be$ with respect to the cerium isotopes are included for $^{144}Ce$, $^{95}Zr$, $^{95}Nb$, $^{103}Ru$, and $^{106}Ru$. The most important mechanism of acquirement is hypothesized to be due to attachment of rain droplets to the leaf surface and diffusion of the soluble radionuclide to the leaf cuticle, where it is fixed chemically or admitted to the interior. Dry dust deposition appears to be a relatively unimportant mechanism of permanent fixation. (auth)

**19561** (DHEW/FDA-75-8010) 6TH ANNUAL NATIONAL CONFERENCE ON RADIATION CONTROL: NEW CHALLENGES, APRIL 28–May 2, 1974, SAN ANTONIO, TEXAS. (Bureau of Radiological Health, Rockville, Md. (USA)). Oct 1974. 299p. (CONF-740483-). GPO.

Separate abstracts were prepared for 31 papers included. (CH)

*For abstracts of individual papers see: 19324, 19546–19548, 19562–19564, 19579, 19938–19948, 20093, 20094, 20109, 20550, 21287, 21288, 21292, 21881, 21885, 21886, 21899 and 21900.*

**19562** (DHEW/FDA-75-8010, pp 45–50) STATUS OF AEC–STATE COLLABORATION. Beck, C. K. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Cooperation between Federal agencies and the states in radiation monitoring of nuclear facilities, regulating the transport of radioactive materials across state boundaries, and the selection of sites for nuclear power plants is discussed. (CH)

**19563** (DHEW/FDA-75-8010, pp 254-258) AEC INDEPENDENT MEASUREMENTS PROGRAM. Weiss, B. H. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The U.S. Atomic Energy Commission's radiological and environmental protection inspections of nuclear power plants are discussed. The role of the States in assisting in this task and criteria for evaluating State Laboratories and the performance of States under monitoring contracts are reviewed. The Directorate of Regulatory Operations divides the radiological and environmental inspections into four functional areas: Environmental Protection; Radiation Protection; Emergency Planning; and Waste Management. Environmental protection inspections are concerned with the applicant or licensee's actions directed toward limiting adverse environmental impacts because of radiological and nonradiological insults. The initial inspection, approximately 3 months after issuance of the Construction Permit and the first several routine inspections would be almost exclusively concerned with nonradiological matters. Emphasis on radiological monitoring begins about 2 years before anticipated operation. Routine annual inspections will be conducted thereafter for the lifetime of the plant. Where special problems are identified, the inspection frequency may be increased and where licensee management demonstrates good control there could be some relaxation of the schedule. Radiation protection inspections focus on protection of the health and safety of plant personnel. An initial inspection is conducted at least two years prior to issuance of an operating license. A more detailed preoperational inspection is scheduled for one year prior to OL issuance. Then three months prior to fuel loading, an inspection is made to determine if there are any outstanding items that may prevent issuance of the OL. For operating plants the minimum inspection frequency is one per year, except that an inspection is conducted soon after issuance of an operating license and during the first refueling outage. A detailed inspection of emergency planning is scheduled to begin about two years prior to OL issuance and a followup to determine resolution of deficiencies or significant changes is made just before the OL is issued. Thereafter, routine annual inspections are made. Waste management inspections relate to the operation of liquid and gaseous waste systems and monitoring of the various effluent streams. The preoperational inspections are initiated approximately two years before anticipated OL issuance. A more detailed preoperational inspection is conducted about one year later. Just prior to issuance of the OL, an inspection is conducted to assure that the licensee has completed his preoperational program. During the power ascension phase another inspection is made, and thereafter annual waste management inspections are conducted. Various techniques are utilized in conducting an inspection. The most significant are interviews, observation of activities, checking of

some records, testing, and independent verification. The objective is to determine if programs are being properly managed and the requirements of AEC regulations and license conditions are being met. (CH)

**19564** (DHEW/FDA-75-8010, pp 259-264) IS ENVIRONMENTAL MONITORING NECESSARY? Shealy, H. C.; Hazle, A. J.; Gerusky, T. M. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Radiological environmental surveillance programs of Colorado, South Carolina, and Pennsylvania are reviewed. The value of State programs for radiation monitoring are illustrated by the incidents reported. (CH)

**19565** (NIIAR-P-214) RADIATION CONDITIONS ON THE NIIAR SITE. Dem'yanovich, M. A.; Knyazev, V. A.; Kotikov, P. I.; Laptev, V. G.; Moshkin, V. D.; Checketkin, Yu. V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1973. 21p. (In Russian). INIS.

Consideration is given to problems of organizing control of the external medium in the region where the Research Institute of Atomic Reactors is situated. It is shown that the accident-free development of a complex of nuclear units is safe for the surrounding population. Analysis of the results of radiometric studies of samples from the external medium in the period from 1967 to 1970 showed that the amounts of radioactivity are at background levels, and are caused by global fallout and the presence of natural radioisotopes in the samples. From an estimate of the dose at the local site it was possible to conclude that the size of the protective zone has a definite reserve, by reason of which it was possible to increase the amount of radioactive gases discharged to the atmosphere. (tr-INIS)

**19566** (RN-66259) PROPOSAL FOR RADIOLOGICAL MONITORING SERVICES TO U. S. ATOMIC ENERGY COMMISSION, NEVEDA OPERATIONS OFFICE. (Aerojet-General Corp., Sacramento, Calif. (USA)). 5 Dec 1966. 160p. Dep. NTIS $11.00.

Proposals are presented for furnishing radiation monitoring services at remote locations at the Nuclear Rocket Development Site in Nevada. The qualifications of personnel and proposed subcontractors are presented in detail. (CH)

**19567** RADIATION ECOLOGY. Schultz, V. (Washington State Univ., Pullman); Whicker, F. W. Contract AT(11-1)-1156. CRC Crit. Rev. Environ. Contr.; 14: No. 4, 423-464(Oct 1974).

Radiation ecologists are concerned with the relationships between ionizing radiation or radioactive substances and the environment. When introduced into the universal media air or water, radionuclides become dispersed and diluted, transported over varying distances, and usually concentrated in specific living and nonliving components of the environment. The fate of radionuclides in the environment is governed by a highly complex mosaic of physical, chemical, and biological factors. The fact that nearly all components of the environment contain at least traces of natural and man-produced radioactivity has stimulated considerable interest in radionuclide dispersion, transport, and concentration in most major ecosystems important to man. Of primary interest are the rates of movement of radionuclides within and between ecosystem components, the mechanisms responsible for such movements, and the degree of concentration of radionuclides. A great deal has been published on effects of ionizing radiation on plants and animals, particularly within levels of biological organization extending from the molecular to organismal level. However, very little effort had been devoted to effects of ionizing radiation on field populations or community levels of organization prior to 1960. At the community level direct effects of radiation on individuals become intertwined with indirect effects of many multiple interactions and secondary effects. Thus, changes observed in a community following irradiation are caused not only by ionizing radiation per se, but also by interactions and secondary effects which result from the inherent nature of that community and its supportive elements. Without a good deal of ancillary information, the relative importance of factors responsible for observed changes in an irradiated community may be obscure. One of the most fundamental features of communities which explains many changes observed following irradiation is the widely varying radiosensitivities of different organisms. The U. S. and the U. S. S. R. have rather extensive research programs in radiation ecology. Past and current endeavors by these countries as well as others are revealed in the literature cited or listed. It is rather difficult to list the major centers for training radiation ecologists as many contributions to this field of endeavor have been made by persons not trained in depth in this field. Academic programs developed specifically for the training of radiation ecologists are not common. Perhaps this results from our artificial classification of a training program into this category. We would consider such a program as one which requires training in the basic sciences, namely mathematics, chemistry, physics, and biology as well as specialized disciplines, such as ecology, nuclear physics, health physics, and radiation biology. Although in depth training in these disciplines would vary among students, the overall program should stress ecological principles. (auth)

**19568** GAMMA RADIATION MEASUREMENTS AROUND A NUCLEAR POWER STATION. Bramati, L.; Fiori, S.; Faini, F. (ENEL-DCO, Rome). G. Fis. Sanit. Prot. Radiaz.; 17: No. 3-4, 72-79(1973). (In Italian).

The paper illustrates an experiment of direct measurements on gamma radiation levels from the Garigliano Station gaseous releases by means of a GM detector connected with a scaler and printer. The experiment, which lasted 40 days, permitted to measure the fluctuations of the natural background with the station shutdown, and the radiation levels as a function of the released activity and meteorological conditions. The results will be utilized for the preparation of a long-term research program to realistically evaluate the doses absorbed by the inhabitants in the areas around the station and to set up a calculation method of the exposure from the cloud as a function of the meteorological parameters and of the radioisotope mixture released. (auth)

**19569** RADIOACTIVE FALLOUT DEPOSITION: STATUS OF WORK IN SWITZERLAND. Schweiz. Bauztg.; 92: No. 13, 323(28 Mar 1974). (In German).

Proposed construction of nuclear power stations in Switzerland led to controversy over the possibility of radioactive fallout. Studies were undertaken by a consortium involving NAGRA (Director, M. Thut). In the first phase, studies involving oil, gas, and salt samples from caverns, were undertaken. A second phase was concerned with seismic and gravimetric studies, especially of anhydride and gypsum formations. Some 22 rock formations were studied since August 1973. Test borings are planned for 1975, and further research for 1976. (INIS)

**19570** ASSESSMENT OF ENVIRONMENTAL RADIATION DOSE FROM AIRBORNE EFFLUENTS USING REAL TIME METEOROLOGICAL DATA. Sitaraman, V.; Sastry, P. L. K.; Patel, P. V.; Shirvaikar, V. V. (Bhabha Atomic Research Centre, Bombay). pp 317-327 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Airborne radioactive effluents from nuclear plants should be limited such that the total environmental dose to individual members of the public does not exceed the limit set by the ICRP or a fraction of it apportioned to dose via air. The dose can either be evaluated from real time meteorological data or be measured directly by continuous recorders. In India it was found that the first approach has the advantages that: (i) the entire environmental dose field can be computed in contrast to only few, localized measurements that could be made using radiation recorders; (ii) the low level of external dose rates (μrem/h or less) makes continuous radiation monitoring difficult; (iii) with the recent trend of reducing the permissible environmental dose levels increasing reliance has to be kept on indirect estimates; and (iv) in the case of multiple installation sites monitoring stations will not be able to give contributions from individual plants. This information might sometimes be useful in the assessment and limiting of release rates of any individual installation. The measured environmental doses from release of $^{41}Ar$ from the CIRUS reactor are satisfactory compared with the estimates obtained from meteorological data and the site characteristics. (auth)

**19571** POPULATION EXPOSURE EVALUATION BY ENVIRONMENTAL MEASUREMENT AND WHOLE-BODY COUNTING IN THE ENVIRONMENT OF NUCLEAR INSTALLATIONS. Bhat, I. S.; Khan, A. A.; Hegde, A. G.; Somasundaram, S. (Bhabha Atomic Research Centre, Bombay). pp 337-344 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Measurements of the extent of environmental radioactive pollution from the operation of nuclear installations in India are carried out at the installation sites. Environmental measurements and evaluation of annual dose to individual members of the public, mainly in the environment of Tarapur Atomic Power Station due to the radioactive waste releases from the plant are described. Samples of all kinds of food materials are collected at regular frequency and analyzed for radioactivity. Demographic survey of the microenvironment of the nuclear site has given the spectrum of local diet and per capita consumption of food items. From these environmental data the per capita daily intake of critical radionuclides and the resultant internal radiation exposure to individual members of the general population are evaluated. The external population exposure due to stack discharges from nuclear installations is measured by thermoluminescent dosimeters. The increase in dose observed during operation over the natural background and its variation as seen during the pre-operational period is evaluated as the direct exposure. Whole-body counting of the general population has been carried out to evaluate internal contamination of individuals. Representative members of each village are counted about 3 times a year and the average annual body burden is evaluated. The annual dose due to the body burden is estimated for the important radionuclides found in the villagers. The population dose commitment due to nuclear operation in the country is assessed on the basis of present observation for the environment of the nuclear installations. (auth)

**19572** PROGRAMME FOR MONITORING THE MARINE ENVIRONMENT AROUND THE LA HAGUE CENTRE. Scheidhauer, J. (CEA, Cherbourg, France); Ausset, R.; Planet, J.; Coulon, R. pp 347-366 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The La Hague Centre, the main function of which is the reprocessing of irradiated fuel, is located by the sea at a site particularly favorable as regards the safety of the local population. Before the reprocessing plant went into operation, extensive studies were carried out in order to determine how the effluent from it would disperse and by what major pathways it could reach the local population. The results of these studies led to the formulation of a monitoring programme covering 12 zones and various elements of the marine environment: seawater, sediments, algae, fauna not involved in the food chain, and fauna of importance in the food chain. Only after 1968 did the findings reveal certain effects attributable to the Centre, the extent of the effects depending on the type of sample and the zone. Algae proved to be the best indicators: the measured activities correlated fairly well with the amounts of effluent discharged and the concentration factors were in agreement with the basic hypotheses. As regards the fauna, the activity levels are generally too low for a correlation with the effluent discharges to be established. (auth)

**19573** PRACTICAL METHOD OF ASSESSING RADIATION DOSES TO THE POPULATION. The Use of Reference Levels and Some Results of Their Application to Italian Sites. Boeri, G.; Brofferio, C. (CNEN, Rome). pp 413-422 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

See STI/PUB-375; CONF-740529-.

Some results on the use of derived reference levels, as adapted to evaluate environmental surveillance data collected around Italian nuclear installations are presented. A comparison is made between theoretically derived reference levels and actually measured environmental concentrations of radioactivity in order to assess radiation doses to the population and to investigate the environmental behavior of radioactive effluents. (auth)

**19574** ENVIRONMENTAL CHARACTERISTICS OF THE DANUBE RIVER SYSTEM AND THE PROBLEMS OF RADIOLOGICAL SAFETY STANDARDS. Tasovac, T.; Radosavljevic, R.; Zaric, M. (Inst. of Nuclear Sciences, Belgrade). pp 427-432 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

As many environmental parameters affect the behavior of different radionuclides introduced into the environment, it is necessary in evaluating the population dose commitment to have at one's disposal, among others, the results of rather complex environmental studies. Such complex environmental studies are especially important in assessing the doses from and defining the operating conditions of nuclear installations located beside large international rivers. By analyzing the results of radioecological studies carried out on the River Danube in Yugoslavia and other riparian states, the problems of setting the maximum permissible concentrations of radionuclides in this aquatic system are discussed. (auth)

**19575** RADIATION DOSE TO POPULATION (CREW AND PASSENGERS) RESULTING FROM THE TRANSPORTATION OF RADIOACTIVE MATERIAL BY PASSENGER AIRCRAFT IN THE UNITED STATES OF AMERICA. Barker, R. F.; Hopkins, D. R.; Tse, A. N. (Atomic Energy Commission, Washington, DC). pp 595-611 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Radiation exposures to passengers and crew members in passenger aircraft carrying packages of radioactive material are controlled by regulations that limit the radiation dose rate outside each package and the number and positioning of such packages as loaded in one type of aircraft. The actual radiation level in mrem/h at 3 feet from the external surface of the package is defined in the USA as the package transport index (TI). The regulation specifies that the TI for any package shall be no greater than 10. A table in the regulations specifies a maximum value for the sum of TI for the packages that can be loaded into a single aircraft, depending on the available separation distances between the surface of the packages to the partition of the passenger's compartment. Observation of TI and separation distance ensures that radiation levels in passenger and crew compartments are within predetermined levels. Measurements were made of radiation dose rates in passenger seats and at crew stations after routine shipments of packages of radioactive material had been loaded normally by carrier personnel into the cargo compartments of regular flights. By analyzing these dose rates and the corresponding TI of the packages loaded, a relationship between average radiation dose rate and total TI per flight was established. Statistics on the total TI per flight, number of passengers and crew, and duration of flights were gathered by 9 airlines for all their passenger flights from 33 airports across the country, and these data were extrapolated to account for all flights nationwide. The total TI on each flight was translated into average radiation dose rates in the passenger and crew compartments, and the data were used to estimate the annual cumulative dose from the transportation of radioactive material by passenger aircraft. The methods of analysis are described, and the calculation used in arriving at the estimated annual cumulative dose is presented. The annual cumulative dose due to cosmic radiation at the elevation at which commercial aircraft fly is estimated and compared. (auth)

**19576** THE EXTERNAL RADIATION DOSES DUE TO RECENT FISSION PRODUCTS DEPOSITED IN THE SACAVEM REGION BETWEEN OCTOBER 1964 AND MARCH 1968. Fonseca, A. J. R. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). Rev. Port. Quim. (Lisbon); 11: 133-141(1970). (In Portuguese). (DOC-LFEN-112g).

Also available as report from Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal.

The external radiation doses due to recent fission products deposited in the Sacavém (Portugal) region between October 1964 and March 1968 were calculated using a modified version of the method described by Halden and Harley for a uniform surface distribution of the same products. A short discussion follows concerning the precision and limitations of this method. (INIS)

**19577** RADIOAKTIVNI ZAMORENI BIOSFERY. (Radioactive Contamination of the Biosphere). Benes, J. Prague; Ceskoslovenska Akademie Ved (1974). 232p. (In Czech). 14,-Kcs.

The radioactivity of the biosphere is considered from the chemical and physical viewpoint. The topics considered are a description of the biosphere, radioactivity in the biosphere, cosmic radiation, natural sources of ionizing radiation, human radiation dose from natural sources, artificial radioactive isotopes, radioactive wastes, radioactive fallout, radioactivity of the atmosphere, radioactive aerosols, radioactivity of water, radioactivity of the soil, radioactivity of plants, movement of radio-

active material in the biosphere, contamination of organisms by radioactive material, and protection against ionizing radiation. (JSR)

## Atmosphere

*Refer also to abstracts 19549, 19679, and 20077.*

**19578** (COO-3257-8) STUDIES OF COLLOIDAL PARTICLES; SCAVENGING OF AEROSOL PARTICLES BY A FALLING MACROSCOPIC PARTICLE. Final Report, May 1, 1968–April 30, 1974. Kerker, M. (Clarkson Coll. of Tech., Potsdam, N. Y. (USA)). [nd]. Contract AT(11-1)-3257. 15p. Dep. NTIS $4.00.

Collection efficiencies of falling water drops ranging from 0.094 to 0.254 cm in radius for silver chloride aerosol particles in nitrogen ranging from 0.15 to 0.6 μm in radius have been measured. The drops accelerated for distances ranging from 30 to 515 cm prior to entrance into the scavenging chamber. Results were extrapolated to terminal velocity. The results for the slower moving drops (30 cm acceleration distance) agreed roughly with the predictions of a theory based upon collection by Brownian diffusion. However, near terminal velocity, Brownian diffusion theory did not account for the results. Instead, for each value of particle radius $\alpha$, the collection efficiency was a sharply increasing function of the impaction parameter P. Results by other workers for particles of different density agreed approximately with our values, provided comparisons were made at the same values of $\alpha\rho^{1/2}$ where $\rho$ is the particle density. Calculations of washout coefficient indicated that the half-life of 0.1-μm aerosol particles is of the order of one day for moderate rainfall rates. However, this result is strongly dependent upon the particular raindrop size distribution. (auth)

**19579** (DHEW/FDA-75-8010, pp 234-240) DOSE MODELING FOR NUCLEAR FACILITIES. Martin, J. A. Jr. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The Environmental Protection Agency's Office of Radiation Programs is developing a computerized Comprehensive Dose Calculational System (CDCS) to support its standard setting activities. Portions of CDCS will include environmental transport and dose models which will accept source terms as input and will calculate the movement of radionuclides from source to man to provide data on dose and health effects. One of these submodules of CDCS, a code called AIREM, is discussed in detail. This code calculates diffusion doses, ground depositions, and population doses resulting from atmospheric releases of radionuclides. Excellent correlations between field measurements and surveillance data and AIREM model predictions have been observed. The use of a verified model such as AIREM can be a cost-effective adjunct to a surveillance or monitoring program. It can also be used to obtain an overview of changes in the radiological quality of the environment due to nuclear fuel cycle operations. The code runs in about 20 seconds on an IBM 360 computer with a G level compiler and 190k storage. It is written in elementary FORTRAN and is extensively annotated, hopefully facilitating its use. (auth)

**19580** INVESTIGATION OF THE RADIOACTIVITY OF THE ATMOSPHERIC LAYER CLOSE TO THE WATER IN THE ATLANTIC (JANUARY–APRIL 1973). Vinogradov, A. S.; Domanov, M. M.; Kodochigov, P. N.; Nelepo. B. A.; Trusov, A. G. Sov. J. At. Energy (Engl. Transl.); 36: No. 2, 181-184(Feb 1974).

Translated from At. Energ. (USSR); 36: No. 2, 145-147(Feb 1974).

Results of measurements of radioactivity in the atmospheric layer near the water are presented. Radioactivity in the Northern hemisphere was caused by nuclear testing by the Peoples' Republic of China, while radioactivity in the Southern hemisphere was determined by French nuclear testing on the Mururoa Atoll in the Pacific. Air sampling techniques are described and concentrations of $^{7}Be$, $^{137}Cs$, and $^{144}Ce$ are tabulated for January to April, 1973. (HLW)

**19581** URANIUM MINE VENTILATION WITH REGARD TO RADON AND ITS DAUGHTER PRODUCTS. Sadilek, P. (Uranove Doly, Hamr u Ceske Lipy (Czechoslovakia)). Rudy (Prague); 22: No. 1, 9-11(Jan 1974). (In Czech).

A method of calculating the ventilation is described envissaging effective ventilation of between 0,03 and 0,3 exchange of air per minute. On the basis of a practical measurement of the observed mine sections, and by comparing the measured and the computed values it was ascertained that the exchange of air in the mine had a decisive effect on the toppling of the balance between Rn and its daughter products. Therefore, for the observation of the maximum permissible concentration of radon daughter products, the desirable amount of air is a function of radon abundance and volume and also the measure of intake air pollution. (INIS)

## Soil

*Refer also to abstract 19550.*

**19582** SORPTION-DESORPTION OF RADIOACTIVE CAESIUM, STRONTIUM, AND CERIUM ON EARTH COMPONENTS. Pirs, M. (Jozef Stefan Inst., Ljubljana, Yugoslavia). pp 539-551 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The sorption capacity on humus material, calcite and dolomite for cesium, strontium, and cerium was determined by static and dynamic measurements. The dependence of the equilibrium concentration on the solution, pH, the presence of foreign salts and the stability of the fixation of the above-mentioned ions has been investigated. The elution curves for Cs, Sr, and Ce from the humus material, sand, calcite and dolomite with water, salt solutions and acids were calculated. (auth)

## Water

*Refer also to abstracts 19667 and 19682.*

**19583** (INS-R-125) ANALYSIS OF RADIOACTIVITY TRACING MEASUREMENTS IN COASTAL WATERS. Wallace, G. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Physics and Engineering Lab.). Jun 1973. 55p. INIS.

A method is described for the analysis of activity measurements made in coastal areas following the injection of radioisotopes into the sea. By assuming that the injected activity simulates a fraction of the pollutant from an outfall, it is shown how tracing measurements permit an estimation of pollution levels in the receiving waters. (auth)

**19584** COASTAL MARINE POLLUTION AND FISH. Waldichuk, M. (Pacific Environment Inst., West Vancouver, B. C.). Ocean Manage.; 2: No. 1, 1-60(Mar 1974).

**19585** ISOTOPIC RATIOS OF RADIORUTHENIUM AND RADIOCERIUM IN RAIN WATER AT OSAKA IN RELATION TO NUCLEAR EXPLOSIONS DURING THE PERIOD OF LATE 1969–1972. Matsunami, T.; Mizohata, A.; Mamuro, T. (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Radiat. Res.; 15: No. 2, 96-102(Jun 1974).

The isotopic activity ratios of $^{103}Ru$ to $^{106}Ru$ and $^{141}Ce$ and $^{144}Ce$ in rain water were studied during the period from the end of 1969 to August, 1972. The ratios demonstrated many peaks during the observation period, each of which was likely to result from settlement of stratospheric or tropospheric nuclear debris produced by nuclear explosions during the same period. The method of distinguishing fresh nuclear debris from old debris on the basis of measured radiostrontium activity ratios, developed by Telegadas and Murayama, was applied to estimate the contributions of the $^{106}Ru$ and $^{144}Ce$ produced by a new explosion to the total depositions of these nuclides from the measured activity ratios of $^{103}Ru$ to $^{106}Ru$ and $^{141}Ce$ to $^{144}Ce$. The contributions thus estimated ranged from zero to nearly 100%, depending on various factors. (auth)

**19586** NATURAL RADIOACTIVITY OF MINERAL WATERS. Mastinu, G. G.; Santaroni, G. P. (CNEN–CSN, Rome). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 9-13(1974). (In Italian).

The study of natural radioactivity of the mineral waters of a country is a valid starting point for the radiological survey aiming to evaluate natural radionuclide levels and their distribution through the food chain and in the environment. Besides it could contribute to a better knowledge of the dose effect relationship and to the evaluation of the doses at natural levels necessary for accurately assessing the dose limit to the population. Comments are reported on the procedures for measuring $^{222}Rn$ and $^{226}Ra$ in the water and data presented on the concentration of $^{226}Ra$ in some Italian mineral waters. The radiological significance of these results is also discussed in connection with the values of the concentration factors of the various means through which the radionuclides may move to man. (auth)

**19587** RADIOECOLOGICAL INVESTIGATIONS IN THE GULF OF TARANTO. Schreiber, B.; Tassi Pelati, L.; Mezzadri, M. G. (Univ., Parma, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 49-54(1974). (In Italian).

The Department of Zoology of Parma University has carried out since 1968 a wide program of radioecological investigations in the Taranto Gulf (Ionian Sea) to evaluate the radioactivity level in the various marine substrata as water, plankton, benthic organisms, and sediments before the beginning of radioactive discharges from the Trisaia reprocessing plant. In collaboration with the Radiochemistry Laboratory of CISE (Milan) the following artificial radionuclides were determined in sea water, plankton, and sediments: $^{54}Mn$, $^{60}Co$, $^{90}Sr$, $^{95}Zr$, $^{125}Sb$, $^{137}Cs$, $^{144}Ce$, $^{147}Pm$, and $^{155}Eu$. The specific activity detected was very low as in the period of our research the only radioactive contribution was due to fallout. (auth)

**19588** EVOLUTION OF ARTIFICIAL RADIOACTIVITY IN FLUVIAL SEDIMENTS. Smedile, E. (ENEL, Milan); Triulzi, C. G. Fis. Sanit. Prot. Radiaz.; 17: No. 3-4, 119-124(1973). (In Italian).

Results of radiochemical analysis of $^{90}Sr$, $^{137}Cs$, $^{144}Ce$, $^{147}Pm$, $^{155}Eu$, $^{134}Cs$, $^{60}Co$ contained in some sediment samples collected in different stations of the Po river and of North Adriatic Sea are presented. Comparison of the granulometric distribution for some river samples is also reported. Moreover data and considerations about the seasonal variability of $^{137}Cs$, $^{134}Cs$ and $^{60}Co$ in sediment samples collected in the river near the E. Fermi nuclear power reactor (Trino Vercellese) are presented. (auth)

**19589** RESEARCH ON THE RADIOACTIVE POLLUTION OF LAKE SANTO PARMENSE. Mezzadri, M. G.; Tassi Pelati, L. (Univ. Parma, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 26-39(1974). (In Italian).

In the frame of a radioecological investigation started in 1969 at lake Santo Parmense some artificial radioisotopes were identified and determined in several lacustrine samples. The high $^{137}Cs$ content in sediments is probably due to the peculiar characteristics of the lake, to the meteorological conditions of the zone, and to the strong interaction between $^{137}Cs$ and bottom material. By means of a very simple compartment model of the lake it was possible to evaluate its depuration capacity for $^{90}Sr$. (auth)

**19590** TRANSFER OF $^{137}Cs$ AND $^{90}Sr$ FROM THE ENVIRONMENT TO THE JAPANESE POPULATION VIA MARINE ORGANISMS. Ueda, T.; Suzuki, Y.; Nakamura, R. (National Inst. of Radiological Sciences, Chiba, Japan). pp 501-511 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

During the period from 1963 to 1971 we investigated the contamination levels of marine organisms, total diet and individual foodstuffs due to $^{137}Cs$ and $^{90}Sr$ from fallout. The results are summarized as follows. The concentrations of $^{137}Cs$ and $^{90}Sr$ in marine organisms show a decreasing tendency since 1963, closely resembling that of seawater. The concentration factors and observed ratios, calculated from radioactive elements, are in good agreement with those from stable elements. The ratios of the specific activities of marine organisms to that of seawater (expressed in annual mean values) were found to be almost 1, except the case of Sr in fish bone. The total mean $^{137}Cs$ contribution for each of nine foodstuffs was observed; the contribution of cereals was about 40% of the total $^{137}Cs$ intake, followed by beans, milk and its products, leafy vegetables and fish. The $^{90}Sr$ contribution of leafy vegetables was the highest (34%), followed by beans (20%) and cereals (18%). The internal radiation dose rate received by the Japanese population is estimated to be 7.3 mrad, of which the contribution of marine foods was less than 10% from $^{137}Cs$ in the total diet between 1963 and 1971. (auth)

**19591** ESTIMATION OF RADIATION DOSE RATES TO FISH IN CONTAMINATED ENVIRONMENTS, AND THE ASSESSMENT OF THE POSSIBLE CONSEQUENCES. Woodhead, D. S. (Ministry of Agriculture, Fisheries and Food, Lowestoft, Eng.). pp 555-575 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The disposal of radioactive waste into coastal waters, rivers, and lakes may produce localized conditions in which fish experience radiation dose rates in excess of that from the natural background. Reasonably realistic estimates of these dose rates may be obtained by combining data on the levels of radioactivity in the water, sediments and fish with simple dosimetry models. Where the dose rates are sufficiently high it has been possible to provide confirmation of the estimates, using in situ thermoluminescent dosimeters. A knowledge of the radiation regime, together with information on the effects of irradiation on fish, provides a basis for assessing the consequences for fish populations in contaminated environments. (auth)

**19592** IN SITU STUDY OF A NATURAL AQUATIC ECOSYSTEM CONTAMINATED BY TRITIATED LIQUID EFFLUENTS WITH A VIEW TO EVALUATING THE SENSITIVITY OF THE PARAMETERS INVOLVED IN ASSESSING POPULATION EXPOSURE LEVELS. Bittel, R. (CEN, Fontenay-aux-Roses, France); Kirchmann, R.; Van Gelder-Bonnijns, G.; Koch, G. pp 613-621 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The ecosystem in question is a small watercourse that receives liquid effluents from complex nuclear facilities and intermittently feeds a series of ponds used for fish-rearing. The system was investigated for about a year, the tritium concentrations in water and sediment samples and in plant and animal organisms being determined. The accent was placed on measurement of the tritium incorporated in organic matter, the specific activity of the combustion water being determined in each case. It is higher than that of the stream and pond water by a factor of as much as 100. This conflicts with observations, made in situ and in laboratory aquaria, regarding the transfer of tritium in the form of tritiated water so that one must look for biologically available tritiated compounds in the effluents. It would appear, therefore, that the physicochemical state of the tritium is a sensitive parameter of particular importance for predicting and evaluating population exposures. (auth)

**19593** PRINCIPLES OF SUBSTANTIATING PERMISSIBLE CONCENTRATIONS OF RADIOACTIVE SUBSTANCES IN FRESHWATER BODIES. Marey, A. N.; Barkhudarov, R. M. Gig. Sanit.; No. 1, 50-54(1974). (In Russian).

Permissible irradiation doses for man accepted by the national sanitary law were assumed as the base in the standardization of radioisotopes in water bodies. The entry of radioactive isotopes into man's body with drinking water, their migration from the water body by the food chains, and the action of ionizing radiation from the surface of the water body and the floodlands were taken into account. (Pollut. Abstr.)

**19594** CUMULATION OF RADIOACTIVE SUBSTANCE IN DAM RESERVOIRS. Kwapulinski, J. (Instytut Gospodarki Komunalnej, Chorzow, Poland). Acta Hydrobiol.; 15: No. 2, 215-225(1973).

Systematic investigations on the accumulation of $\beta$ radioactive substances by the benthos, periphyton, plankton, phytoplankton, zooplankton, bottom sediment, and higher plants in limnetic and rheolimnetic reservoirs showed that the cumulation coefficient was of the order $10^3 - 10^5$. The cumulation coefficient for the bottom sediment and periphyton was influenced by hydrobiological parameters. (Pollut. Abstr.)

## Ecosystems and Food Cycles

*Refer also to abstracts 19216, 19548, 19671, 19672, 19674, 19676, 20004, 20098, and 20108.*

**19595** (FOA-4-C-4573) TRANSFER OF SIMULATED FALLOUT PARTICLES FROM PASTURE TO GRAZING DAIRY CATTLE. IV. Further Experiments With Wet and Dry Deposited 100 to 200 $\mu$m-Particles and Wet Deposited 1 $\mu$m-Particles. Ekman, L.; Eriksson, A.; Greitz, U. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1974. 22p. INIS.

The transfer of simulant fallout particles from pasture to grazing cows has been studied in nine field experiments. The experiments were performed with wet and dry deposited 100 to 200 $\mu$m particles and with wet deposited 1 $\mu$m particles. The fraction of deposited material ingested by the animals was assessed by assay of the radioactivity content in feces. On the average 14 (range 4 to 28) % of the wet deposited 100 to 200 $\mu$m particles was consumed by the grazing cows. During the

time period 1969 to 1972 21 experiments with wet deposited 100-200 μm particles were carried out. A mean initial retention of 16 (range 4 to 28) % can be calculated from all these studies. Based on these three year experiments it seems reasonable to assume that the initial retention of close-in fallout deposited in connection with precipitation will vary between 4 and 28%. The retention of dry deposited 100 to 200 μm particles was studied in four experiments. On the average 11 (range 4 to 23) % of deposited amounts was consumed by the cows. Based on totally eight experiments carried out 1971 and 1972 it was found that on the average 9 (range 1 to 23) % was consumed. On the average 37 (range 12 to 60) % of deposited 1 μm particles was recovered in feces of the cows. To get some information on the retention of the particles on the grass deposition occurred on two adjacent pens simultaneously. On one pen the cows started grazing immediately after deposition and on the other pen five days after deposition. No definite conclusion could be drawn from the limited number of experiments carried out to study the retention of fallout simulant particles on the grass a few (five) days after deposition but the results suggest that the field loss of particles has been surprisingly small. (INIS)

**19596** (GSF-K-12) GENERAL PROBLEMS IN FOOD CONTAMINATION. Feldt, W. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F. R. Germany). Inst. fuer Strahlenschutz). Jun 1974. 22p. (In German). INIS.

A review provided with numerous tables and drawings on the radioactive contamination of food is presented. Possibilities are shown of how radionuclides penetrate into the biosphere and the radio-ecologic chains that enable them to enter food. The contamination values in food that are dangerous are presented and the problem of the relevant measured values is discussed. The various possibilities of food decontamination are briefly explained and then given more accurately for a few important foods such as milk, meat, cereal, and fish. The significance of food contamination is demonstrated by three example situations (limited nuclear catastrophe, nuclear war, and long-term situation). (GE)

**19597** (RLO-2227-T12-47) RADIOACTIVE ZINC ($^{65}$Zn), ZINC, CADMIUM, AND MERCURY IN THE PACIFIC HAKE, MERLUCCIUS PRODUCTUS (AYRES), OFF THE WEST COAST OF THE UNITED STATES. Naidu, J. R. (Oregon State Univ., Corvallis (USA). Dept. of Oceanography). Jun 1974. 173p. Dep. NTIS $11.75.

Thesis.

The Pacific Hake, Merluccius productus (Ayres), was used to monitor the coastal waters off the West Coast of the United States and Puget Sound for Zn, $^{65}$Zn, Cd, and Hg. This study revealed that the Columbia River is not the source for Zn, Cd, and Hg but was the main source for $^{65}$Zn as of January 29, 1971. Since then with the phasing out of all the plutonium production reactors at Hanford, the $^{65}$Zn activity in the river water, and therefore in sea water off the West Coast of the United States, has approached minimum detection levels. (CH)

**19598** DISTRIBUTION OF PELAGIC BACTERIA IN THE LIGURIAN SEA AND THEIR POSSIBLE ROLE IN THE RECYCLE OF RADIONUCLIDES IN THE MARINE ENVIRONMENT. Peroni, C.; Lavarello, O. (CNEN-EURATOM, Sarzana, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 40-48(1974). (In Italian).

An autoradiographic method is described based on the $^{32}$P uptake by marine bacteria. By using this technique, a distribution curve of viable marine bacteria in the Ligurian sea has been obtained. High concentrations of metabolizing bacterial cells (about $10^4$/ml) are detected in the surface layers. The concentrations observed are much higher than the numbers counted by the usual cultural methods (10 to 50 cells/ml). The bacterial concentration decreases progressively from the surface to reach nonsignificant values below 200 m depth. The results obtained in our laboratory concerning the role bacteria play in the $^{32}$P uptake by the copepod Euterpina acutifrons are discussed. The very few data available in the literature on the uptake of radionuclides by marine bacteria and the energy and activity transfer to higher trophic levels via bacteria are reviewed. Our results confirm the importance of bacteria in the transfer of radionuclides in the food chain. The bacterial distribution observed has also important consequences from the radioecological standpoint and its influence on conventional and radioactive waste disposal in the sea is briefly discussed. (auth)

**19599** ROLE OF THE FRESHWATER PERIPHYTON IN THE CONCENTRATION OF HEAVY METALS AND RADIONUCLIDES. Queirazza, G.; Smedile, E. (ENEL, Trino Vercellese, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 17-25(1974). (In Italian).

By periphyton is meant the plant animal populations that cover each substrate immersed in water. The purpose of the research was to estimate the capacity of concentration of periphyton in relation to community structure and variations of the most important limnological parameters. This paper deals mainly with research conducted in 1971 and 1972 as follows: C. F. for: Fe - Mn - Zn - Cu - Cr - Co - Pb - Cd - Mo. C. F. for the radionuclides of ecological importance. On the basis of the results set out it is possible to demonstrate for the periphyton a C. F. which is higher than for concentrator organisms such as molluscs and water plants. (auth)

**19600** ECOLOGICAL AND RADIOECOLOGICAL RESEARCHES ON THE FOOD-WEB IN A STRETCH OF THE PO RIVER. Smedile, E.; Tibaldi, E. (Univ., Milan). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 14-16(1974). (In Italian).

A description of the trophic structure of the Po river is presented. The food-web seems in that stretch very complex. Results are reported of a comparative gamma spectra study carried out on the organism (periphyton and fishes collected monthly from August 1971 to May 1972) belonging to two trophic levels. The largest number of radioelements were concentrated at a level of the primary producers. (auth)

**19601** KONTAMINATION AND DEKONTAMINATION VON LEBENSMITTELN. Nr. 12. (Contamination and Decontamination of Foods. No. 12). Fischer, E. (comp.). Bibliographien zur Kernforschung und Kerntechnik, Sektion 02. Leopoldshafen, F. R. Germany; ZAED (1974). vp. (In German). (ZAED-BIBL.-02-12).

This bibliography covers conference papers, reports, and journal articles dealing with the contamination and decontamination of foods. The literature compiled under section C00, Contamination, discusses various groups of foodstuffs separately and in detail, whereas section D00, Decontamination, covers the literature on methods for agriculture and food industry, and solid foods. Other topics dealt with in the work reported are legislation and radiation protection, general aspects and analysis and measurement of radioactivity, as well as radioecology, which is a separate section. (GE)

**19602** KONTAMINATION UND DEKONTAMINATION VON LEBENSMITTELN. Nr. 13. (Contamination and Decontamination of Foods. No. 13). Fischer, E. (comp.). Bibliographien zur Kernforschung und Kerntechnik, Sektion 02. Leopoldshafen, F. R. Germany; ZAED (1974). vp. (In German). (ZAED-BIBL.-02-13).

This bibliography covers literature on the contamination of foodstuffs. In the literature reported, general aspects such as legal regulations in this field and radiation protection problems are also dealt with, as well as topics such as environmental and food chain radioecology and radiobiological effects. Most of the publications, however, are concerned with contamination, with a distinction being made between diets and feed for livestock, animal products and plant products, and beverages and drinking water. The types of literature reported in this issue are conference papers, reports, and journal articles. (GE)

**19603** CONTAMINATION OF PLANTS WITH STRONTIUM 90. Herchl, M.; Svitel, J. (Komenskeho Univerzita, Bratislava (Czechoslovakia). Farmaceuticka Fakulta). Voj. Zdravot. Listy; 43: No. 1, 29-31(Jan 1974). (In Slovak).

A brief survey is presented of the manner of plant contamination with radionuclides, mainly with $^{90}$Sr. The biological chain is described of the transport of the radionuclide from the soil to the human organism. Characteristics of $^{90}$Sr contamination are listed, and two convenient methods of determining $^{90}$Sr activity are explained. (INIS)

**19604** TRANSFER OF RADIONUCLIDES TO MAN THROUGH ENVIRONMENTAL PATHWAYS. Mitchell, N. T. (Ministry of Agriculture, Fisheries and Food, Lowestoft, Eng.). pp 485-500 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The most widely accepted method in current use for the evaluation of environmental impact from releases of radioactivity that may cause human radiation exposure used an environmental pathway model. The more important aspects of the model involve the use of critical pathway techniques to set controls on the releases of radioactive material to the environment and to assess the human radiation exposure arising as a consequence. The basic concepts of the environmental pathway model and its application are discussed. The model depends on achieving an understanding of radionuclide behavior in the environment, from the moment of release up to the time when contamination results

in radiation exposure to the public. Exposure may be as a result of contaminated material entering the body — as air, water or a foodstuff; alternatively, it may be due to radiation whose source is external to the body. For each of these types of exposure pathway the sequence of events can be divided up into a number of compartments, between which transfer takes place. Transfer along the pathway is a dynamic process and can be described mathematically in terms of transfer functions between interacting compartments. Alternatively, for the situation of a regular discharge resulting in a steady-state condition the relationship between compartments can be expressed as a "concentration factor". The derivation of both of these terms is described and some aspects of their use are discussed. The types of environmental pathway encountered as a result of release of radionuclides to the atmospheric and aquatic environments are discussed. Disposal to the ground is regarded as a special case of release to the aquatic environment. Some of the literature on the subject is reviewed in discussing the better known pathways showing what, to date, have been the most important mechanisms of transfer of radionuclides to man. (auth)

**19605** EFFECTS OF RADIOECOLOGICAL RECONCENTRATION ON MAXIMUM PERMISSIBLE CONCENTRATIONS FOR RIVER WATER. Schaeffer, R. (Electricite de France, Paris). pp 525-538 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The $MPC_W$ values recommended by ICRP take into account only one contamination pathway, the ingestion of water. In order to take into account the second contamination pathway, the food chain in the case of river water, it is therefore necessary to reduce the MPC value. The author describes the method for calculating the reduction coefficient, taking by way of example contamination by caesium-137 and strontium-90. Account is taken of two essential phenomena, the adsorption of radionuclides by river sediments and the movement of fish, which result in a higher concentration factor for fish with increasing distance from the point of discharge; this would largely explain the disparity of the concentration factor values given in the literature. However, the increase in the concentration factor value is less rapid than the decrease in the water concentration resulting from adsorption by sediments, so that the value of the coefficient by which the MPC value should be divided decreases as the distance from the discharge point at which the fish is caught increases. Bearing in mind also the concentration factors typical of plants, the coefficient barely exceeds 20 under the worst possible circumstances, if the population in question is near the discharge point, and declines to a much lower value in the case of more distant populations. (auth)

**19606** HAZARDOUS SUBSTANCES IN CEREALS: A PROBLEM OF CONSUMER PROTECTION. Seibel, W.; Ocker, H. D. Muehle Mischfuttertech.; 111: No. 11, 163-166(Mar 1974). (In German).

Paper read at the "scientific information meeting of the Berliner Gesellschaft fuer Getreideforschung e.V." of January 23rd, 1974.

The exposure of cereals to various harmful materials, among others radionuclides, is considered. Artificial radioactivity is only a fraction of the natural radioactivity and it is estimated that a larger use of nuclear power plants will not increase the content of long-lived harmful radionuclides. (GE)

## Radiometric Techniques

*Refer also to abstracts 19671–19673, and 20602.*

**19607** (PB-233989) WELL-LOGGING TECHNIQUES FOR MINERAL DEPOSIT EVALUATION: A REVIEW. Information Circular. Scott, J. H.; Tibbetts, B. L. (Bureau of Mines, Washington, D. C. (USA)). Jun 1974. 50p. (BM-IC-8627). GPO $0.90.

Well-logging techniques used to evaluate various types of mineral deposits are discussed briefly, and many pertinent references are cited. Information is categorized by mineral commodity to make it easy to determine what logging techniques have been used for evaluating specific metals and non-metals. Logging techniques are described as applied to deposits of the following metals: aluminum, antimony, beryllium, boron, copper, iron, lead and zinc, manganese, mercury, nickel, silver and gold, tin, tungsten, and uranium. Information is also provided for well-logging of the following nonmetals: coal, evaporites, fluorspar, oil shale, rock salt, and sulfur. Separate bibliographies are given for English and foreign language references. (GRA)

**19608** (RLO-2227-T7-28) USE OF ARTIFICIAL ACTIVABLE TRACE ELEMENTS TO MONITOR POLLUTANT SOURCE STRENGTHS AND DISPERSAL PATTERNS. Shum, Y. S.; Loveland, W. D.; Hewson, E. W. (Oregon State Univ., Corvallis (USA)). 1974. 25p. Dep. NTIS $4.25.

A tracer technique using certain of the rare earth elements such as dysprosium (Dy), samarium (Sm), lanthanum (La), and cerium (Ce) that can be neutron activated was developed for the analysis of air pollution problems. The method employing these stable activable tracers was applied to determine whether the available meteorological dispersion models can be used effectively to monitor pollution emissions from selected industries in the vicinity of Albany, Oregon. The Gaussian plume model was found to be satisfactory for the moderately intense turbulence fields that characterize Stability Types B, C, and D, including cases in which the pollution was trapped by an inversion layer aloft. For lower sources, however, it was necessary to make allowance for urban influences on plume dispersion. A box model best described the observed dispersal pattern when the upward penetration of the very intense turbulence of Stability Type A was limited by an inversion layer alfot. These meterological models along with multiple regression analysis were applied using a "blind" experimental procedure to predict the emission rates of the effluent from multiple sources of air pollution in the Albany area. These techniques can be used to predict and hence to monitor the rate of emission within a factor of two for multiple sources consisting of three stacks. It appears from the initial success of these experiments that, using activable trace elements that naturally occur in a stack effluent rather than the artificial ones employed in the present study, the method might be extended to locate unknown or unsuspected sources of air pollution. (auth)

**19609** (STI/PUB-373(Vol.I)) ISOTOPE TECHNIQUES IN GROUNDWATER HYDROLOGY. Volume I. Proceeding Series. Conference Held in Vienna, Austria, March 11-15, 1974. (International Atomic Energy Agency, Vienna (Austria)). Aug 1974. 511p. (In several languages). (CONF-740312-P1). IAEA $24.00.

Separate abstracts were prepared for the 27 papers included. (CH)

*For abstracts of individual papers see: 19617–19643.*

**19610** (STI/PUB-373(Vol.2)) ISOTOPE TECHNIQUES IN GROUNDWATER HYDROLOGY. Volume II. Proceeding Series. Conference Held in Vienna, Austria, March 11-15, 1974. (International Atomic Energy Agency, Vienna (Austria)). Sept 1974. 508p. (In several languages). (CONF-740312-P2). IAEA $24.00.

Separate abstracts were prepared for the 24 papers presented in these proceedings. (ERB)

*For abstracts of individual papers see: 19644–19667.*

**19611** ADVANCES IN INORGANIC GEOCHEMISTRY. Puchelt, H. (Tuebingen Univ. (F. R. Germany). Mineralogisch-Petrographisches Inst.). Fortschr. Chem. Forsch.; No. 44, 155-176 (1974).

2 tabs.; 180 refs.

A review is given on data and methods of analytic geochemistry on statistic methods and evaluations, ore deposits, geochemical prospecting, hydrogeochemistry, the development and the present state of ocean chemistry, geochemistry of stable and radioactive isotopes, geochemistry of the environment, crystal chemistry and element distribution as well as geochemical models with detailed literature indications. (GE)

**19612** TECHNICZNE ZASTOSOWANIE METODY ATOMOW ZNACZONYCH. (Technological Applications of Labeled-Atom Methods). Akerman, K. Warsaw; Wydawnictwa Naukowo-Techniczne (1970). 513p.

This book describes the application of labeled-atom techniques to studies on chemical-reaction mechanisms, kinetics of technological processes, flow of gases, liquids, and solids, mixing and dispersion, quantitative measurements, wear, and materials identification. Applications in geology, hydrology, meteorology, and criminalistics are included. Theoretical bases of the methods are discussed, and certain basic data are presented in the appendix. The book is designed for engineers in various fields. (550 references) (TTT)

**19613** CLIMATIC SIGNIFICANCE OF DEUTERIUM ABUNDANCE IN GROWTH RINGS OF PICEA. Schiegl, W. E. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). Nature (London); 251: No. 5476, 582-584(18 Oct 1974).

Deuterium variations in growth rings of a picea from southern Germany are essentially a function of annual air temperature. Short term isotope variations are partly influenced by changes of relative humidity, but it is the long-term annual temperature fluctuations that are mainly responsible for the deuterium variations in the rings. Long-term deuterium variations in picea record climatic changes in the past and also reflect the deuterium content of the annual precipitation. (auth)

**19614** ACTIVITY OF LABELLED INJECTION SEDIMENTS FOR EXPERIMENTS IN DYNAMIC SEDIMENTOLOGY. Gaspar, E.; Ilie, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 26: No. 7, 715-724(1974). (In Rumanian).

Criteria are presented for the determination of minimum activity used in a radioactive tracer experiment in dynamic sedimentology. When radioactive tracers are applied to the direct measurement of the sediment transport rate of sand beds in the sea, the activity may be calculated on the basis of three criteria: metrological, statistical, and radioprotection. Both theoretical formula based on this criteria and field experiments conclude that a 3 Ci $^{182}$Ta source is enough to obtain good results in the sand bed measurements. Graphs and formulas for activity necessary in transport rate of the sand bed studies are presented as well. (auth)

**19615** RADIOGEOCHEMICAL FEATURES OF NEAR-SURFACE GOLD ORE DEPOSITS AND THEIR PROSPECTING VALUE. Grebenchikov, A. M.; Khrust, A. R.; Chepizhnaya, E. A. Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 10, 44-49(Oct 1974). (In Russian).

The peculiarities of the distribution of natural radioactive elements in deposits suggest the use of gamma spectrometry for discovering hydrothermalites that are promising for finding gold deposits and at the limits of vein areas for mapping ores of various compositions. Exposed zones of endogenic haloes of radioactive elements may be used in prospecting for blind deposits in the limits of analogous ore fields and deposits with near-surface mineralization. Zones with high uranium and thorium contents in the deposits are formed by their extraction from the rock and redeposition at the edges of the ore zone rather than as a result of the introduction of their hydrothermal solutions. (tr-auth)

**19616** ANNEALING STUDIES ON RADIATION DAMAGES IN BIOTITE, APATITE AND SPHENE AND CORRECTIONS TO FISSION TRACK AGES. Nagpaul, K. K. (Kurukshetra Univ. (India). Dept. of Physics); Mehta, P. P. (Government College, Kurukshetra, India); Gupta, M. L. (Ladwa District, Kurukshetra, India). Pure Appl. Geophys.; 112: No. 1, 131-139(1974).

Fission track ages need to be corrected for the loss of fossil tracks due to geological and thermal annealing. The range distribution of full-length tracks can yield such corrections if calibration curves translating length reductions are available. Study of the annealing characteristics of the three terrestrial minerals, i.e., biotite, apatite, and sphene, as functions of temperature and time, was completed from this point of view. A linear relation was observed between etchable track length and track density, but slopes and intercepts of the curves tend to vary from mineral to mineral. Over-etching shows significant effect in retrieving partially faded tracks in the case of biotite only, and track density reduction always lags behind track length reduction. In apatite and sphene track density is reduced in the same proportion as track length when length reduction is approximately 30 to 50%. For length reductions <10%, track density remains nearly unaffected and for length decrease >50% the density reduction progressively outweighs the former. The possible reasons for such variations and the usefulness of the calibration curves are briefly discussed. (auth)

**19617** SIX YEARS' ENVIRONMENTAL TRITIUM PROFILES IN THE UNSATURATED AND SATURATED ZONES, GROENHOEJ, DENMARK. Andersen, L. J. (Geological Survey of Denmark, Copenhagen); Sevel, T. pp 3-20 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol. 1); CONF-740312-(P1).

The rate of infiltration and downward movement of soil water in the unsaturated zone and the ground water in the upper part of the saturated zone were investigated using environmental tritium in precipitation and subsurface water. Four tritium profiles were measured at the same site during the period March 1966 to November 1972. A model for evapotranspiration (recharge and a displacement-flow model with dispersion) was tested with reference to data on precipitation, evapotranspiration, and soil-moisture using environmental tritium as a tracer with satisfactory results. Tritium balances for the unsaturated zone during the period 1966 to 72 were set up. Frequent measurements of soil-moisture profiles showed a downward movement of a front of gravity water with a velocity about 3 to 3.5 m monthly. However, the actual flow velocity of the soil-moisture determined by environmental tritium was 4.5 m yearly. Evapotranspiration and recharge to the ground water was calculated for the period 1961 to 72. (auth)

**19618** SANDHAUSEN SHALLOW-GROUNDWATER TRITIUM EXPERIMENT. Atakan, Y. (Univ., Heidelberg); Roether, W.; Muennich, K. O.; Matthess, G. pp 21-43 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Observations of environmental tritium were carried out over several years in a shallow unconfined aquifer composed of fine to coarse sand, in the alluvial plain of the Upper Rhine river, Federal Republic of Germany. The observations reached to a maximum of 75 m depth but were concentrated in the top 15 m of the ground (the top 12 m of ground water). For the period 1967 to 1971, the vertically integrated tritium content was near 500 TU · m $H_2O$, and the depth of fallout tritium influence increased from about 10 to 25 m below the ground water table. A ground water recharge rate of 164 mm yearly (standard error ±25%) is deduced (for an assumed porosity of 0.30; precipitation averages 686 mm yearly), from a balance with the tritium supplied by precipitation. The largest contribution to the error arises from estimating the tritium concentration in the recharge water from that of precipitation, whereas the amount of tritium deposited in the ground can be determined to probably ±10%. The recharge rate is consistent with the results of other investigations. In a forest clearing in the area that is elsewhere covered by high pine trees, the tritium deposition was higher by nearly 50%. Excessive tritium concentrations were found at localities downstream from small depressions in the ground that expose the water-table. (auth)

**19619** TRITIUM DATA FROM GROUNDWATER IN THE KRISTIANSTAD PLAIN, SOUTHERN SWEDEN. Persson, G. N. (Geological Survey of Sweden, Stockholm). pp 45-56 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Tritium analyses were performed twice a year since 1963 on ground water from a number of wells on the Kristianstad plain in southern Sweden. Most wells penetrate down into Cretaceous limestones and glauconitic sandstones. According to the tritium contents and the changes in the tritium contents the wells have been classified in four groups, characterized in the following way: Group 1, wells with low tritium values, generally below 3 TU (tritium units) through the whole observation period; Group 2, wells with low-to-intermediate and increasing values; Group 3, wells with high and increasing values; Group 4, wells with initially increasing, then decreasing values. It is concluded that there is a very slow recharge of water to the Cretaceous aquifers in the Kristianstad plain. Under certain circumstances the recharge has increased locally because of pumping. (auth)

**19620** ENVIRONMENTAL TRITIUM IN THE UNSATURATED ZONE: ESTIMATION OF RECHARGE TO AN UNCONFINED AQUIFER. Allison, G. B.; Hughes, M. W. (CSIRO, Glen Osmond, Australia). pp 57-72 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Extraction of water from 11 soil cores taken vertically allowed determination of the natural tritium profiles in the unsaturated zone at three different sites in Australia. These sites have the same geographic location and a mean annual rainfall of ~750 mm annually. Comparison of observed and model tritium profiles shows that piston-type flow of soil-water dominates below the root zone (~1.5 m), but above this, direct input to beneath the surface of the soil assumes importance. Estimation of recharge to ground water from the tritium profiles, using both profile shape and the total quantity of tritium held in the soil profile, shows that mean annual recharge varies between 40 and 140 mm annually for the three sites. Multiple coring at two of the three sites established that a recharge estimate made using a single core has a coefficient of variation of 15 to 20%. (auth)

**19621** RECHARGE OF A DOLOMITIC AQUIFER AS DETERMINED FROM TRITIUM PROFILES. Bredenkamp, D. B.; Schutte, J. M.; Du Toit, G. J. (Dept. of Water Affairs, Pretoria). pp 73-95 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

The recharge of a dolomitic aquifer has been derived from an interpretation of the fallout tritium variation with depth in the soil overburden. The evaluation is based on the premise that the ground water recharge is primarily a stratified propagation of soil moisture and that the temporal variations of tritium in the precipitation are preserved in the soil. The tritium concentration of 1958 and 1962 to 63 precipitation is known to have been increased significantly by admixture of fallout tritium. The depth to which this precipitation penetrated could be inferred from the tritium concentrations in the soil profile, and permitted the calculation of ground water recharge. Three different methods were used to interpret the data of 13 tritium profiles. An average annual recharge of 30 ± 5 mm yearly derived from the tritium profiles was of the same order as that obtained independently from rainfall input models, and is equivalent to 5.4 ± 1% of the average annual precipitation. (auth)

**19622** SOIL-MOISTURE TRANSPORT IN ARID SITE VADOSE ZONES. Isaacson, R. E. (Atlantic Richfield Hanford Co., Richland, WA); Brownell, L. E.; Nelson, R. W.; Roetman, E. L. pp 97-114 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Soil-moisture transport processes in the arid soils of the United States Atomic Energy Commission's Hanford site were evaluated. The depth of penetration of meteoric precipitation was determined by profiling fallout tritium at two locations where the water table is about 90 m below ground surface. In situ temperatures and water potentials were measured with temperature transducers and thermocouple psychrometers at the same location to obtain thermodynamic data for identifying the factors influencing soil-moisture transport. Neutron probes were used to monitor soil-moisture changes in two lysimeters, three meters in diameter by 20 meters deep. The lysimeters are also equipped to measure pressure, temperature, and relative humidity as a function of depth and time. Theoretical models based on conservation of momentum expressions are being developed to analyze non-isothermal soil-moisture transport processes. Future work will be concerned with combining the theoretical and experimental work and determining the amount of rainfall required to cause migration of soil-moisture to the water table. (auth)

**19623** USE OF ENVIRONMENTAL ISOTOPES AND ARTIFICIAL TRACERS TO STUDY RECHARGE TO GROUNDWATER IN THE BURDEKIN DELTA, QUEENSLAND. Airey, P. L.; Calf, G. E.; Hartley, P. E.; Roman, D.; Spragg, W. T. (Australian Atomic Energy Commission Research Establishment, Sutherland). pp 115-126 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Nuclear techniques were applied to the study of the ground water hydrology of the Burdekin River Delta of Queensland, Australia. Recharge occurs from the river, from the artificial recharge facilities, and from precipitation. The approximate boundary between the aquifer sands and the overlying alluvium has been determined from the natural gamma logs of available bores. Portions of the aquifer which are confined, or partly confined, were delineated by comparison with available standing water level contours. An extensive survey of fallout tritium levels was made. The results are interpreted on the basis that the underground water is stored in a single homogeneous aquifer and moves from defined recharge areas along the maximum piezometric gradient at about 0.4 m · $d^{-1}$. The decrease in the tritium levels with sampling depth is discussed. Tracer techniques are being developed to study the clogging of recharge pits with river sediments. A new seepage meter was developed to facilitate the rapid, quantitative measure of seepage rates at specific points. (auth)

**19624** NEW INSIGHTS INTO THE RUN-OFF MECHANISM BY ENVIRONMENTAL ISOTOPES. Martinec, J. (Federal Inst. for Snow and Avalanche Research, Weissfluhjoch, Switzerland); Siegenthaler, U.; Oeschger, H.; Tongiorgi, E. pp 129-143 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

Subsurface flow and groundwater recharge were studied in the alpine watershed of Dischma in Switzerland using variations of tritium and $^{18}O$ content. Snowmelt discharge dominates the yearly run-off pattern. Day-to-day computations are based on the assumption that one part of meltwater reaches the outlet of the basin immediately while the other part follows as a recession flow. Independently, fallout tritium measurements reveal that the greater part of the meltwater production infiltrates and contributes to the recharge of groundwater reserves. This build-up of subsurface storage increases the discharge of water stored hitherto in the subsurface reservoir, thus maintaining the quantitative run-off balance. The exponential model and a mathematically derived dispersion model of age distribution give the best agreement with tritium data indicating an average residence time of groundwater of 4.5 and 4.8 years respectively. Variations of $^{18}O$ in the run-off are small in comparison with precipitation, probably caused by fractionation effects. The $^{18}O$ composition of the discharge water is very close to the long-term average of the isotopically lighter precipitation in the winter and the heavier values in the summer. (auth)

**19625** ANALYSIS OF A RUN-OFF HYDROGRAPH BY MEANS OF NATURAL $^{18}O$. Mook, W. G. (Groningen Univ., Netherlands); Groeneveld, D. J.; Brouwn, A.E.; Van Ganswijk, A. J. pp 145-155 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

A deviation of the oxygen isotopic composition in precipitation from the average $^{18}O/^{16}O$ in groundwater can be considered to indicate the presence of some $^{18}O$ tracer. In this way the precipitation component in the discharge of a catchment area can be established. In a small drainage basin (650 ha) the direct peak run-off in the stream channels from a rain storm is shown to consist of rainwater above a slowly increasing base flow. The fast run-off contains two components: overland flow with a time constant of 1 h; and a moderately declining component (time constant of 12 h) probably caused by the release of bank storage. From a complex storm it is shown that 87% infiltrates into the soil and the remaining 13% is drained within a few days. (auth)

**19626** USE OF ENVIRONMENTAL ISOTOPES TO INVESTIGATE THE CONNECTION BETWEEN SURFACE AND SUBSURFACE WATERS IN THE NAGYKUNSAG REGION, HUNGARY. Deak, J. (Research Inst. for Water Resources Development, Budapest). pp 157-167 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

The replenishment and flow conditions of the subsurface waters of the Great Hungarian Plain were investigated with environmental isotopes as part of a research program lasting several years. On the basis of the age data of two water samples, a flow velocity of 0.6 m yearly can be estimated for the Upper Pannonian layers with a flow direction from the Mátra mountain towards the Great Plain. This value can also be considered possible on the basis of hydrologic data. In the Nagykunság region subsurface waters are said to flow upwards. The primary purpose of the investigation was to decide whether these waters would mix with the shallow groundwater of the area, or whether their collecting basis is the Tisza river. Analyses of $^{3}H$ and $^{2}H$ have established that, in the area investigated, shallow groundwater is not supplied at a significant rate from artesian water. A suitable relationship has been found between the tritium concentration of shallow groundwater and the quality of the top layer. This concentration decreases from the sand through the loess and the clayey loess to the clay. The quantity of deep subsurface water mixing with the water of the Tisza river was determined by means of the reduction of the $^{3}H$ concentration in the river. On the 300-km long section of the river, between the villages of Polgár and Algyö, the yield of artesian water mixed with the river water was found to be 17 ± 11 $m^3/s$. More accurate results are expected on the basis of samples to be taken in the period when yield in the Tisza river is considerably smaller. (auth)

**19627** GEOHYDROLOGY OF THE KAIKOURA PLAIN, MARLBOROUGH, NEW ZEALAND. Brown, L. J. (Dept. of Scientific and Industrial Research, Christchurch, New Zealand); Taylor,

C. B. pp 169-189 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Geological, hydrological, and isotopic evidence (tritium, deuterium, and $^{18}O$) are combined to aid the interpretation of the groundwater hydrology and post-glacial geology of the Kaikoura Plain, a small alluvial plain (about 150 $km^2$), deposited in Quaternary time by the Kowhai and Hapuku Rivers and by minor local streams, and located in Marlborough Province on the north-east coast of New Zealand's South Island. Three distinct gravel aquifers (water table, non-flowing artesian, and flowing artesian) are shown to occur beneath Kaikoura Plain, the groundwater being derived in varying proportions from Kowhai River (by bed infiltration), from the minor streams emerging from the adjacent mountain slopes (by infiltration through the stream fans where they emerge over the Plain), and by direct infiltration of precipitation on and between the stream fans in the higher parts of the Plain. (auth)

**19628** ENVIRONMENTAL ISOTOPES AS A HYDROGEOLOGICAL TOOL IN NICARAGUA. Payne, B. R.; Yurtsever, Y. (IAEA, Vienna). pp 193-202 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Variations in the environmental isotopic composition ($^{18}O$, deuterium, and tritium) of precipitation and ground water were used to determine the relative importance of recharge from precipitation on the Chinandega Plain in Nicaragua with respect to precipitation on the higher slopes of the Cordillera de Marrabios. The variation of the $\delta^{18}O$ content of precipitation with altitude was found to be $-0.26‰$ per 100 m. The best estimate of the long-term $\delta^{18}O$ value for recharge from precipitation at a given altitude was obtained from the isotopic composition of a spring at 800 m and ground water which was deemed to represent recharge on the plain on the basis of isotope and hydrogeological information. It was concluded that recharge to the deep aquifer from elevations higher than 280 m is more significant than recharge by precipitation on the plain. (auth)

**19629** KALAHARI GROUNDWATERS: THEIR HYDROGEN, CARBON, AND OXYGEN ISOTOPES. Mazor, E. (Univ. of the Witwatersrand, Johannesburg); Verhagen, B. T.; Sellschop, J. P. F.; Robins, N. S.; Hutton, L. G. pp 203-225 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Tritium and $^{14}C$ measurements revealed several cases of post-nuclear bomb-test rain recharge of local ground waters in South Africa, along with values indicating recharge over larger, yet hydrologically active, time scales. In general, recharge seems to follow rain distribution in being more intense in the northern rather than in the southern Kalahari. Initial $\delta^{13}C$ values vary over a wide range and reveal some correlation to pH and chemical composition of the water. They cannot be used to correct for fossil carbon dilution in $^{14}C$-age calculations. Radiocarbon-deduced ages range from recent to 30,000 years. Stable deuterium and $^{18}O$ ratios indicate recharge from direct rain infiltration. (auth)

**19630** ISOTOPIC STUDY OF THE CONTINENTAL INTERCALAIRE AQUIFER AND ITS RELATIONSHIP WITH OTHER AQUIFERS OF THE NORTHERN SAHARA. Gonfiantini, R. (IAEA, Vienna); Conrad, G.; Fontes, J. Ch.; Sauzay, G.; Payne, B. R. pp 227-241 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974). (In French).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

The Northern Sahara region in Algeria, Libya, and Tunisia contains several aquifers, the largest of which is that of the Continental Intercalaire formations. In its eastern part the aquifer is confined and presents a very homogeneous isotopic composition. The fallout $^{14}C$ activity is low or zero except in the outcrop zones of the north (Saharan Atlas), the east (Dahar) and the south (Tinrhert), all of which are recharge zones. In these areas the isotopic composition does not differ appreciably from that of the old water in the confined part of the aquifer. In the western part, where the reservoir outcrops widely, the $^{14}C$ activities show the extent of the local recharge. The heavy isotope content indicates the overflow of the surface aquifer of the western Grand Erg into the Continental Intercalaire over the whole Gourata front. The mixtures thus formed pass under the Tademait and drain towards the Touat. In the resurgence zone of the Gulf of Gabes in Tunisia the heavy-isotope content confirms the recharging of the aquifer of the Complex terminal by drainage of water from the Continental Intercalaire through the El-Hamma fault system. The water then runs eastwards, mixing with local contributions. The marine Miocene confined aquifer of Zarzis-Djerba in the Gulf of Gabes receives no contribution from the Continental Intercalaire. The water in the aquifer of the western Grand Erg indicates an evaporation mechanism, probably peculiar to the dune systems, which gives rise to heavy-isotope enrichment compared with the recharge of other types of formations. (auth)

**19631** ENVIRONMENTAL ISOTOPE STUDY OF THE GROUNDWATER REGIME IN LARGE AQUIFERS. Castany, G. (Service Geologique National, Orleans, France); Marce, A.; Margat, J.; Moussu, H.; Vuillaume, Y.; Evin, J. pp 243-258 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974). (In French).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

Environmental isotope geochemistry has been applied in numerous studies of the ground water regime in large aquifers. The value of isotopic methods in this work is borne out by three recent studies on the aquifers of the Maestrichtian Sands and the Continental Terminal of Senegal, the aquifer of the Miocene limestones of Cyrenaica (Libya) and the aquifer of the Jurassic dolomitic limestones of Ain Beni Mathar (Eastern Morocco). Apparent-age ground water charts drawn up on the basis of $^{14}C$ data provide a means of determining present and past aquifer charging conditions and the general characteristics of underground flow (direction and velocity). Comparison of these data with piezometric charts serves to confirm or modify the conclusions reached. The contributions of drainage, which can be responsible for the transfer of large volumes of ground water through the semi-permeable intercalations, can be detected or confirmed by environmental isotopes. In certain cases isotopic geochemistry provides a means of checking the homogeneity or heterogeneity of the aquifer reservoir. Data on the $^{18}O$ contained in precipitation water and ground water have been gathered and interpreted, and the results compared with those obtained with other isotopes. (auth)

**19632** ENVIRONMENTAL ISOTOPES USED IN A HYDROGEOLOGICAL STUDY OF NORTHEASTERN BRAZIL. Salati, E. (Centro de Energia Nuclear na Agricultura, Sao Paulo, Brazil); Menezes Leal, J.; Mendes Campos, M. pp 259-283 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

With the exception of the coastal strip the Brazilian Northeastern region is notoriously characterized by deficient water resources, as a consequence of a low and irregular precipitation, high evaporation and evapotranspiration rates, and soils with low infiltration capacity. For a better understanding of the hydrological problems, isotope techniques were used in this area since 1969. A report is made on the data on environmental isotopes (D, $^{18}O$, T, and $^{14}C$) obtained for the region so far, especially from the eastern part comprising the states of Ceará, Rio Grande do Norte, Paraiba, and Pernambuco. For the crystalline area, the data available indicate that the conditions for recharge are such that the infiltrating water does not undergo significant previous evaporation; the turnover times estimated from T concentration are between 10 and 100 years. For the Potiguar sedimentary basin, the water in the main aquifer, the Açu sandstone, shows very low $^{14}C$ content age of more than 30,000 years, and the deuterium concentration and $^{18}O$ suggested some changes in the climate in the region. (auth)

**19633** REGIONAL AND LOCAL MECHANISMS GOVERNING THE DISTRIBUTION OF DEUTERIUM AND $^{18}O$ IN GROUNDWATER OF THE USSR. Ferronskii, V. I. (Inst. of Water Problems, Moscow); Seletskii, Yu. B.; Polyakov, V. A.; Yakubovskii, A. V.; Isaev, N. V. pp 285-291 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974). (In Russian).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

The origin of the water of a number of artesian basins and also of the Kurile-Kamchatka volcanic zone is determined from the results of mass-spectrometric determinations of D and $^{18}O$. The lowest deuterium content is recorded in the case of infiltrational water (both fresh water and brine) of the Angara-Lena artesian basin, and highest content in that of brines of the Jurassic complex in the South Mangyshlak pennisula. Maximum values for isotopic oxygen displacement are found in the water of mud volcanoes. It is shown that high concentration of $^{18}O$ cannot serve as an indicator of the marine origin of groundwater. Study of the Kara-Bogaz-Gol brines has confirmed the genetic role of deuterium as an indicator of the above-mentioned type even in the case of strong brines. (auth)

**19634** ENVIRONMENTAL ISOTOPE HYDROLOGY IN THE HODNA REGION, ALGERIA. Gonfiantini, R. (IAEA, Vienna); Dincer, T.; Derekoy, A. M. pp 293-316 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol. 1); CONF-740312-(P1).

More than 100 dug and drilled wells were sampled for isotopic studies in the Hodna plain, Algeria, the center of which is occupied by the salt plain of the Chott-el-Hodna. In the zones north and east of the Chott, which have similar hydrogeological characteristics, the shallow ground water is enriched in heavy isotopes compared with the much older deep ground water. This may be caused by a change of the isotopic composition of the recharge waters during the last 30,000 years or so, probably as a consequence of a climatic change. Near M'Sila the shallow ground water was reported to be recharged by deep ground water: stable isotopes demonstrate that this does not occur, and therefore the local low salinity of shallow ground water and the shape of the water table is probably caused by recharge from wadis (a conclusion supported also by tritium results). Studies using $^{14}C$ and stable isotopes (which are correlated) demonstrate also that recent recharge of deep ground water is rather limited. South of the Chott, the difference in isotopic composition between shallow and deep ground water also suggests a change in time of the isotopic composition of the recharge waters. Samples of the shallow ground water collected in the proximity of the Chott (water table depth ~1 m) have significantly high heavy isotope content and salinity, as a consequence of evaporation, and $^{14}C$ and stable isotopes are correlated in deep ground water. The $^{14}C$ is often relatively high, indicating a ground water flow rate higher than in the north, in agreement with the better permeability characteristics of the aquifer. It has been possible to reach these conclusions only by means of isotope techniques, which have thus once more demonstrated their validity and usefulness as a hydrogeological tool. (auth)

**19635** ORIGIN OF ARTESIAN AND THERMAL WATERS DETERMINED BY OXYGEN, HYDROGEN, AND CARBON ISOTOPE ANALYSES OF WATER SAMPLES FROM THE SPERKHIOS VALLEY, GREECE. Stahl, W. (Geological Survey, Hanover); Aust, H.; Dounas, A. pp 317-339 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

Hydrogen, oxygen, and carbon isotope analyses were used to determine the origin of groundwater discharged by artesian wells in the Sperkhios Valley. Three regions of different water types discharged by artesian wells in the Sperkhios Valley can be isotopically distinguished by different positions on the meteoric water line: (a) artesian wells within the old Sperkhios bed between Mexiates and Komma and within the region between Komma, Roditsa, and Anthili (isotope province I): $\delta^{18}O = (-9.36 \pm 0.04)$ ‰; (b) artesian wells of the Moskhokhorion region (isotope province II): $\delta^{18}O = (-8.81 \pm 0.07)$ ‰; (c) artesian wells of the Kalivia region (isotope province III): $\delta^{18}O = (-6.85 \pm 0.41)$ ‰. The isotopic differences of the water samples belonging to different artesian provinces are caused by the different mean altitudes of their catchment areas. The altitude dependence of meteoric water was determined by oxygen and hydrogen isotope analyses of spring water samples from the Sperkhios Valley and its bordering mountains, and is 0.16‰/100 m for oxygen and 1.2‰/100 m for hydrogen. Tritium analyses indicate that the artesian groundwater generally is older than 20 years; the water discharged by artesian wells within the Kaliva region is older than 150 years. The mean altitude of the catchment areas of the Platistomon, Archani, Paleovracha, and Xamza thermal fresh water occurrences is about 1100 m. The isotope data of the hot spring samples fit the meteoric water line fairly well. The isotope analyses of samples from the Psoroneria, Kamena Vourla, Loutra Ipatis and Thermopylae hot springs, and the Kamena Vourla and Loutra Ipatis thermal boreholes indicate relicts of seawater or of connate water of seawater composition in proportions between 67% and 14%. (auth)

**19636** ENVIRONMENTAL ISOTOPES AND MOVEMENTS OF SULPHURATED WATER IN LATIUM, ITALY. Zuppi, G. M.; Fontes, J. C.; Letolle, R. (Univ., Paris). pp 341-361 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974). (In French)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); Conf-740312-(P1).

The isotopic composition of six sulphur-containing springs in Latium was analyzed continuously. These springs represent the emergences of free aquifers charged by precipitations collected on karstified and fissured calcareous and calcaro-dolomitic reliefs. The heavy-isotope content of the precipitations was measured at a number of stations at different altitudes on the Tyrrhenian and the Adriatic sides. The isotopic composition gradients vary widely with the seasons and the reconstitution of the isotopic charging areas requires an examination of the infiltration conditions. In the present case practically all the precipitations participate in recharging. The variations in isotopic composition of the water are interpreted as dilutions between recent shallow ground water and deep well-homogenized ground water. In general the surface contributions are less than 10% except for the small Lavinio spring, where close on two thirds of the water is recent, and the Acquasanta emergence, where the comparative pattern of salt and $^{18}O$ content suggests that the reservoir has a complex mechanism of operation. The dissolved salt, tritium and $^{14}C$ content is compatible with this theory. The $^{34}S$ content of the associated sulfides and sulfates indicates a mixture of two reserves of sulfur, one being deep perivolcanic sulfur and the other sulfur from evaporitic permotriassic sediments. In addition, sulfides and sulfates are linked by an oxidoreduction mechanism. The $^{18}O$ content of the sulfates shows the same characteristics. The results as a whole are in agreement with the conclusions reached by analyzing the salt and $^{18}O$ content of the water circuits. (auth)

**19637** STUDY OF GROUNDWATER RECHARGE AND MOVEMENT IN SHALLOW AND DEEP AQUIFERS IN SAUDI ARABIA WITH STABLE ISOTOPES AND SALINITY DATA. Dincer, T. (FAO Trust Fund Project, Riyadh, Saudi Arabia); Noory, M.; Javed, A. R. K.; Nuti, S.; Tongiorgi, E. pp 363-378 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

The connection between major aquifers and their source of recharge in Saudi Arabia was studied by means of the $^{18}O$ content and the salinity and chemistry of the ground water. In the Wadi Miyah region the chemistry of ground water has shown that no leakage was taking place from the Umm-Er-Radhuma aquifer to the overlying Alat and Khobar aquifers that have a similar $^{18}O$ content. In the same region isotope and salinity data indicate that the ground water in the Neogene aquifier has its source in the Alat and Khobar aquifers. Along the coast of the Arabian Gulf both the $^{18}O$ content of the ground water and its salinity show that the Alat, Khobar, and Umm-Er-Radhuma aquifers are connected. In the Al Hassa region the origin of water in large karstic springs was investigated using piezometric, chemical, and isotopic data and the temperature of the springs. Results indicate that the water of the springs and the ground water in the Neogene aquifer consists of water originating from the Umm-Er-Radhuma aquifer, and that there is mixing of waters that have been subject to atmospheric contamination with uncontaminated and more recent waters. In the Harad region the $^{18}O$ content of ground water indicates old ground water and no substantial recharge taking place. Finally the $^{18}O$ content and salinity of ground water in the alluvial aquifer of Wadi Bishah indicate that isotopic enrichment and higher salinity of the ground water in the irrigated areas is most probably due to the recirculation of the irrigation water. (auth)

**19638** STABLE ISOTOPE CONTENTS OF A MAJOR PRAIRIE AQUIFER IN CENTRAL MANITOBA, CANADA. Fritz, P. (Univ. of Waterloo, Ont.); Drimmie, R. J.; Render, F. W. pp 379-398 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

The regional and seasonal variations of the $^{18}O$ concentrations in several ground water flow systems in a single confined carbonate aquifer in Manitoba, Canada are described. The regional

distribution of the $\delta^{18}O$ values is related to these flows and varies between about –11 and –21 per mille. Variations within individual flow segments are considerably smaller and rarely exceed 3 per mille. The isotopic composition of these ground waters is apparently influenced by the physical characteristics (vegetation cover, gravel pits, etc.) of the different recharge areas. Each area produces gound water with a unique isotopic composition which may vary by as much as 3 per mille between different areas with identical climates. Within flow segments which contain water not older than a few thousand years, a decrease in $^{18}O$ is observed from the recharge to the discharge area. This is possibly due to a change in the recharge pattern after the native vegetation cover has been removed by agricultural activities. These differences in $\delta^{18}O$ values within individual flow segments makes it impossible to compare the $^{18}O$ contents measured in the discharge area with those of the present-day recharge areas. Preliminary $^{14}C$ data indicate that in the southern portion of this aquifer ground water older than 10,000 years is present. There the lowest $\delta^{18}O$ values are found. These ground waters have been recharged in a considerably colder climate than today before a major climatic improvement occurred about 10,000 years ago. A comparison of $^{18}O$ and salinity data enabled the different flow systems to be delineated and the importance of the seasonally varying pumping rates in Winnipeg on the quality of waters from wells in zones of confluence of different systems to be demonstrated. (auth)

**19639** CONDITIONS FOR GROUNDWATER RECHARGE USING NATURAL STABLE AND RADIOACTIVE ISOTOPES TOGETHER WITH ANALOGUE SIMULATION. Dubinchuk, V. T.; Polyakov, V. A.; Kuptsov, V. M.; Seletskii, Yu. B.; Karasev, B. V.; Nechaev, V. I.; Babushkin, V. D.; Kashkovskii, G. N. (All-Union Scientific-Research Inst. for Hydrogeology and Engineering Geology, Moscow). pp 399-429 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974). (In Russian).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

The use of a combination of natural isotopes (D, $^{18}O$, $^{14}C$, $^{234}U/^{238}U$) is reviewed as applied to a study of the conditions under which ground water associated with a strongly fissured and karstic rock massif and drawn into mine inflows is recharged. The isotope study program was drawn up on the basis of analogue simulation data. In the light of data on the isotopic composition of atmospheric precipitations, river run-off and ground water tapped by wells and drawn into mine inflows, an assessment was made of the origin of the ground water (D, $^{18}O$, $^{14}C$ and U), the exchange (residence) time of the water was calculated for the whole exchange reservoir and for individual parts of it (D, $^{18}O$), and the age of the water from different aquifers ($^{14}C$), and then the relative contribution made by water of various origins ($^{18}O$, D, U) was evaluated; the possible relationship was also assessed between Palaeozoic and Cretaceous deposit waters in the area adjoining the zone in which the conical depression develops (D, $^{18}O$, $^{14}C$ and U). Isotopic composition data obtained with stable isotopes are interpreted on the basis of a hydrogeological model with sinusoidal input and output, and are compared with results of independent investigations using other isotopes, analogue simulation data and analyses of mine outflow hydrographs. Despite the approximate nature of the model adopted, satisfactory agreement was observed between the results obtained. The theoretical model used is generalized to cover the case of several inflow components and that of arbitrary time-variation in the input concentration. After analyzing the corollaries of the general solution, theoretical arguments are presented in support of several alternative proposals for assessing the nature and magnitude of ground water flow across relatively impervious formations. For the first time, experimental data were obtained on the radiocarbon content of the Yaskhan fresh water lens in the Kara-Kum desert; the radiocarbon distribution pattern supports the theory of a non-recurrent formation of the main fresh water portion of the lens and also suggests that at present it is recharged through a zone of aeration. (auth)

**19640** GROUNDWATER INVESTIGATIONS WITH ENVIRONMENTAL ISOTOPES. Rauert, W.; Stichler, W. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). pp 431-443 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

The development of measuring techniques for environmental isotopes at the Institute of Radiohydrometry, Munich, is described together with hydrological applications and details of three investigations at present in progress. The preparation times of samples for deuterium and $^{18}O$ analyses have been shortened by new preparation systems. The mass-spectrometric $^{18}O$ analyses are now conducted in an on-line procedure. For gas counting tritium from 20 $cm^3$ water samples a propane synthesis method has been developed with a detection limit of 3 TU. In a hydrological application the mean seepage velocity of surface water in a massif in the Austrian Central Alps was estimated to be about 20 to 55 m/yr by determining the tritium and deuterium content of seepage water taken from a mountain tunnel. Tritium and deuterium analyses were used for investigating the hydrological interrelation between a drinking water spring in Bad Kissingen (Bavaria) and some nearby drinking-water wells. Initial results are given for the measurement of $^{14}C$, $^{13}C$, tritium, deuterium, and $^{18}O$ in brines from springs and deep wells at Bad Reichenhall (Bavaria). (auth)

**19641** ISOTOPIC MEASUREMENTS IN RESEARCH ON SEAWATER INGRESSION IN THE CARBONATE AQUIFER OF THE SALENTINE PENINSULA, SOUTHERN ITALY. Cotecchia, V. (Bari Univ., Italy); Tazioli, G. S.; Magri, G. pp 445-463 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

Cretaceous calcareous and dolomitic rocks, bedded, jointed and karstified, and hence generally very permeable, form the basement of the Salentine Peninsula, Italy. These rocks constitute a huge aquifer with fresh and brackish ground waters that float on ground waters of marine origin. Sea level constitutes the base level of the ground waters. A basic outline is first given of the hydrogeology and the paleohydrogeology, so as to provide the necessary background information on the seawater intrusion phenomenon and to permit comparison of the results of the isotope data with those obtained by the classical methods of hydrogeological investigation. This is followed by presentation of the results of the isotopic measurements on $^{18}O$, D, $^{13}C$ and $^{14}C$. The $\delta^{13}C$ contents indicate, in good agreement with the carbon dioxide and bicarbonate concentrations, that seawater ingression leads to the migration of carbon dioxide from the fresh and brackish waters towards the subjacent intrusive waters of marine origin. Along those stretches of coast where the seawaters are in direct communication with the ground waters, all the isotope data point to very active renewal of ground waters of marine origin by seawater. In the central parts of the peninsula and along those stretches of coast where direct communication between seawaters and ground waters is impeded by impervious clays, the $^{14}C$ contents indicate that the seawater intrusion and consequently the migration of carbon dioxide are either very slow and continuous in time or that they occurred relatively rapidly in the past. Taking into consideration the paleohydrogeology of the peninsula, and the fact that the $\delta^{18}O$ and $\delta D$ values are higher than those of the present seawaters, leads to the belief that seawater instrusion may well have occurred during major variations in the sea level in the past, when climatic conditions were different from those now prevailing. (auth)

**19642** DETERMINATION OF THE ORIGIN OF WATER IN SPRINGS FROM THE SIMULTANEOUS APPLICATION OF NATURAL AND ARTIFICIAL ISOTOPES. Some Aspects of the Origin of Water in the Rashche Spring. Kirkov, P.; Kacurkov, D.; Tolev, M.; Anovski, T. (Center for Application of Radioisotopes in Science and Industry, Skoplje, Yugoslavia). pp 465-479 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.1); CONF-740312-(P1).

The simultaneous application of artificial and natural isotopes ($^{14}C$, tritium, $^{13}C$, $^{18}O$, and deuterium) to determine the origin of water in springs is described for multi-component systems. An attempt was made to solve the origin of water in a karstic spring, the formation of which could derive from various flows (surface and underground) arising from a large precipitation area. The isotopic distribution in the precipitates is uniform. The method was applied to the practical problem of the Rashche Spring in Yugoslavia. The water in the spring originates in the Polog region. The input-output water balance of the Rashche Spring indicates the possibility of the participation of different flows in the spring. Data from natural and artificial isotopes have been taken as a model that is acceptable for different methods of observation including hydrological aspects, which cannot be obtained by natural isotope analysis alone. (auth)

**19643** APPLICATION OF STABLE ENVIRONMENTAL ISOTOPES IN MINE HYDROGEOLOGY TAKING POLISH COAL BASINS AS AN EXAMPLE. Rozkowski, A. (Inst. of Geology,

Sosnowiec, Poland); Przewlocki, K. pp 481-502 of Isotope Techniques in Groundwater Hydrology. Vol. I. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373 (Vol.1); CONF-740312-(P1).

Preliminary results of the stable isotope investigations carried out in Polish coal basins are presented. In the case of the Lublin Coal Basin, the extreme values of $\delta^{18}O$ lie between -10.05 and -4.95‰, and of $\delta D$ from -71.99 to -41.40‰. The tested waters may be divided into two groups regarding the relative isotope content. The first group includes waters with overall mineralization lying between 0.4 and 2.5 g/litre. All the waters from the overburden may be placed in this group, and also most of those from the productive Carboniferous. The low content of heavy isotopes allows this group to be classified as infiltration waters. Hence it must be expected that water inflows to the mines will come from both static and dynamic sources. Waters from the Carboniferous with mineralization higher than 10 g/litre are grouped separately. On the precipitation line these points are shifted to the SMOW values. These waters represent a mixture of relict and infiltration waters. If mining is taken to a depth greater than 1000 m, only a minimal proportion of waters from the dynamic sources in mine inflows need be expected. In the case of the Upper Silesian Coal Basin, extreme values of $\delta^{18}O$ vary from -11.57 to +0.34‰ and $\delta D$ from -72.9 to -1.2‰. From analysis of the diagram showing the relation between $\delta^{18}O$ and $\delta D$ contents the deep infiltration of contemporary atmospheric waters in the productive Carboniferous of the northern, hydrogeologically non-isolated sector of the Coal Basin is evident. In the southern isolated sector of the basin no recent freshening of the waters under Tertiary overburden is observed. In the formations of varied geological age occurring below 600 m, relict waters appear. It may therefore be predicted that inflow to new mines scheduled for construction will be from static resources only. (auth)

**19644** OXYGEN AND HYDROGEN ISOTOPE STUDIES OF THE LARDERELLO (ITALY) GEOTHERMAL SYSTEM. Panichi, C.; Celati, R.; Noto, P.; Squarci, P.; Taffi, L.; Tongiorgi, E. (CNR, Pisa, Italy). pp 3-28 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Data collected on water and steam samples enabled a satisfactory picture of the geochemical and hydrogeological characteristics of the Larderello geothermal field to be obtained. The isotopic and chemical analyses of hot water from non-productive wells and thermal and cold springs enabled two different circulation patterns of fluids to be distinguished. The steam samples delivered from the wells show, as expected, the same deuterium content as local meteoric water, with $^{18}O$ enrichments ranging from 1.7 to 8‰. The geographical distribution of the $\delta^{18}O$ values of steam provides valid information about the preferential path of flow in the zone from which the geothermal fluids are derived. These flow lines are in agreement with the reconstruction of the regional hydrogeological scheme. The presence of tritium in the steam of some peripheric wells has indicated the existence of local influences of recent shallow waters on the deepest circulation. Repeated $^{18}O$ measurements in time of the steam samples have shown the usefulness of the isotopic survey in the control of the evolution of a geothermal field during its exploitation. (auth)

**19645** HOT SPRINGS OF THE IGNEOUS TERRAIN OF SWAZILAND. Their Noble Gases, Hydrogen, Oxygen, and Carbon Isotopes and Dissolved Ions. Mazor, E. (Univ. of Witwatersrand, Johannesburg); Verhagen, B. T.; Negreanu, E. pp 29-47 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-737(Vol.2); CONF-740312-P2.

The hot springs of Swaziland are of great interest as they occur in an area devoid of recent volcanism and issue in igneous, rather than in sedimentary rocks. An origin from directly infiltrating rain water is concluded from the Ne, Ar, Kr, and Xe concentrations, and the $\delta D$ and $\delta^{18}O$ values. The noble gases are shown to have been kept in closed system conditions, and their concentrations lead to the deduction of paleotemperatures at infiltration of 21°C to 31°C, which are similar to the present local summer temperatures. The $^{14}C$ age of the waters is calculated to be 4500 to 5400 years, and tritium concentrations are very low, indicating that the bulk of groundwater is indigenously deep seated. The chemical composition is unique, total dissolved salts being 120 ppM, reflecting contact with igneous as opposed to sedimentary rocks. (auth)

**19646** LOCAL VARIABILITY OF THE ISOTOPE COMPOSITION OF GROUNDWATER. Gat, J. R. (Weizmann Inst. of Science, Rehovot, Israel). pp 51-60 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The local variability of the isotope composition of groundwaters is used to obtain information on the recharge and flow regimes in the aquifer waters. The method is based on repeated samplings of groundwaters on an evenly spaced time and space grid. The spread of isotope compositions is then compared with the scatter resulting from the analysis itself and with the variability of composition of the precipitation. The systems investigated were in the phreatic coastal aquifer of Israel and a limestone mountain aquifer, which is largely confined. In the coastal aquifer 130 wells in a 100 $km^2$ test area showed a bimodal distribution of the $^{18}O$ isotope composition, which is displaced by a few tenths of a per mille relative to mean precipitation. Repeat sampling over eight years of wells in that aquifer also gave very reproducible results. By contrast, in the mountain aquifer both the spatial and temporal variability was greatly in excess of analytical scatter. Space and time inhomogeneity was also found in leakages into a limestone cavern which serves as a natural lysimeter for the recharge to such an aquifer. (auth)

**19647** SAMPLING OF LYSIMETERS FOR ENVIRONMENTAL ISOTOPES OF WATER. Sauzay, G. (International Atomic Energy Agency, Vienna). pp 61-68 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques on groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

A summary is given of the environmental isotopic ($^{18}O$, deuterium and tritium) concentration of rain and of water which has percolated through lysimeters, with the object of establishing a relation between these two parameters. Although this has been possible for one lysimeter only, the data for other lysimeters are discussed in terms of the influence of vegetation cover and agricultural practice. (auth)

**19648** PROBLEMS IN $^{14}C$ DATING OF WATER FROM AQUIFERS OF DELTAIC ORIGIN. An Example from the New Jersey Coastal Plain. Winograd, I. J. (Geological Survey, Reston, VA); Farlekas, G. M. pp 69-93 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Major assumptions common to interpretive studies of $^{14}C$ in groundwater systems are: (a) no $CO_2$ is introduced after recharge; (b) $\delta^{13}C$ of carbonate phases in the aquifer is known and taken to be zero; and (c) inter-formational flow can be neglected. None of these assumptions are fulfilled in deltaic and marginal marine sediments comprising the Potomac-Raritan-Magothy aquifer system of New Jersey; and it is likely that the first two cannot be met in most aquifers of deltaic to marginal marine origin because: (1) variations of pH, $H_2CO_3$, $HCO_3^-$, and $Ca^+Mg$ in the groundwater show a significant amount of $CO_2$ being generated within the Potomac-Raritan-Magothy aquifer to distances of 45 kilometers down the hydraulic gradient. The hypothesis that coalification of ubiquitous lignitic detritus is the source of $CO_2$ described in other deltaic aquifers is tentatively accepted here; (2) the $\delta^{13}C$ of common carbonate mineral phases in deltaic and marginal marine sediments ranges from 0 to -20‰; (3) the aquifer is recharged both by infiltration on its outcrop areas and by leakage from overlying marine strata; the leakage is significantly more mineralized than the aquifer water; the $^{14}C$ content probably also differs. For these reasons, and despite regular variations of $^{14}C$ and $\delta^{13}C$ down the hydraulic gradient, meaningful interpretation of even relative $^{14}C$ ages and groundwater velocities cannot be made in the New Jersey aquifer. Similar difficulties should be expected in all aquifers of deltaic or marginal marine origin unless $^{14}C$ and $\delta^{13}C$ data are supplemented by detailed studies of subsurface stratigraphy, mineralogy, hydrodynamics, hydrochemistry and dissolved gas content. (auth)

**19649** $^{14}C$ EVIDENCE FOR THE ORIGIN OF ARID REGION GROUNDWATER, NORTHEASTERN PROVINCE, KENYA. Pearson, F. J. Jr.; Swarzenki, W. V. (Geological Survey, Reston,

VA). pp 95-109 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

A major natural resource of the arid Northeastern Province of Kenya is a body of fresh groundwater underlying the drainage-ways of the Ewaso Ngiro River and Lagh Dera for about 200 km southeast and east of Habaswein. Twenty samples of this fresh water and surrounding saline water were analyzed for their chemical and radio and stable carbon isotopic composition to investigate mechanisms of recharge of the fresh-water body. No samples contain detectable tritium, and measured $^{14}C$ contents range from 2.8 to 87.7% modern. The higher measured $^{14}C$ values are associated with the fresher water body, but there is no strict correlation between $^{14}C$ and salinity. The samples fall into several groups, the members of each of which show a striking correspondence between measured $^{14}C$ contents and $(C_{tot})^{-1}$ values. The hypothesis to account for this correspondence is that each of the $^{14}C$-$C_{tot}$ groups represents a single recharge event. The different $^{14}C$ contents within each group are due to additions of varying amounts of $^{14}C$ free carbonate (by aquifer carbonate solution or mixing with older water) to water from a single recharge event. Because of lack of general knowledge about arid region carbonate chemistry and lack of samples to show chemical and isotopic variations with depth in the aquifer, we are unwilling to assign absolute ages to these waters. It is probable, though, that the recharge events recurred at intervals of a few millennia. (auth)

**19650** RADIOCARBON, $^{13}C$, AND TRITIUM IN WATER SAMPLES FROM BASALTIC AQUIFERS AND CARBONATE AQUIFERS ON THE ISLAND OF OAHU, HAWAII. Hufen, T. H.; Lau, L. S.; Buddemeier, R. W. (Univ. of Hawaii, Honolulu). pp 111-127 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Principal fresh water aquifers on the subtropical island of Oahu consist of basaltic rocks that are devoid of fossil carbonate minerals. In southern Oahu fresh water occurs as semi-independent basal lenses which float on salt water and are bounded by sedimentary formations along the coast and in valley bottoms. The latter formations contain carbonate aquifers. Fresh water also occurs in dike compartments located in the central parts of the mountains. The radiocarbon content of groundwater recharge on Oahu is between 96 and 100% modern. The $^{13}C$ concentration associated with fresh groundwater is between -17 and -19 $\delta$‰ PDB and remains constant while such waters reside in, or travel through, basaltic rock aquifers. Radiocarbon and tritium data on basal waters withdrawn by major pumping stations show these waters to have ages between a few decades and several hundred years. Differences in these ages relate systematically to individual pumping rates of the stations, well depths and local lens thickness. (auth)

**19651** $^{234}U$ AND $^{238}U$ IN THE CARRIZO SANDSTONE AQUIFER OF SOUTH TEXAS. Cowart, J. B.; Osmond, J. K. (Florida State Univ., Tallahassee). pp 131-149 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The waters of the Carrizo Sand formation of South Texas, United States of America, exhibit a pattern of uranium isotopic disequilibrium, described in terms of $^{234}U/^{238}U$ activity ratio ("A.R.") and uranium concentration, which may be a function of geochemical factors and the hydrologic histroy of the area. In terms of uranium, two regimes seem to exist. The first, including outcrop and near outcrop sample locations, has waters with relatively high concentration and low A.R. Somewhat downdip, the uranium concentration decreases sharply at the downdip limit of the oxidation environment, a zone of uranium precipitation. Recoil of daughter products from the precipitated uranium causes an increase of A.R. of the water. Water of low uranium concentration and high A.R. is found throughout the downdip regime. If a constant input of $^{234}U$ through time is assumed, the downdip decrease in A.R. after the initial introduction of $^{234}U$ into the water may be ascribed to radioactive decay of $^{234}U$. However, this assumption leads to the calculation of a water flow rate one twentieth that determined by other means. Alternatively, this pattern may be an artifact of a change of climate from 20,000 years to 10,000 years ago. In this case, the decrease in A.R. downdip is a function of a varying input of $^{234}U$ as well as decay. (auth)

**19652** $^{234}U/^{238}U$ DISEQUILIBRIUM IN WATERS OF THE JUDEA GROUP (CENOMANIAN-TURONIAN) AQUIFER IN GALILEE, NORTHERN ISRAEL. Wakshal, E. (Hebrew Univ., Jerusalem); Yaron, F. pp 151-177 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Analysis of $^{234}U/^{238}U$ activity ratios and uranium concentrations were carried out on samples from 60 water sources of the Judea Group (Cenomanian-Turonian) carbonate aquifer of Galilee, northern Israel. The $^{234}U/^{238}U$ activity ratios were found to vary from 1.04 to 2.81, and successive analyses of selected water sources showed that values from the same sampling sites remained consistent over a three-year period (1970 to 73). The recorded values of the $^{234}U/^{238}U$ activity ratio may be grouped into three main clusters clearly related to the paleohydrological evolution of the area under consideration: (a) Low $^{234}U/^{238}U$ activity ratios ranging from 1.04 to 1.72 (the majority not exceeding 1.55) were reported from the water sources of western Upper Galilee. This area is drained into the Mediterranean, and its meteoric groundwater circulation regime is as old as the Neogene. (b) Intermediate $^{234}U/^{238}U$ activity ratios (1.65-1.93) are common among the water sources of the Pleistocene Jordan Rift Valley catchment area. (c) Higher $^{234}U/^{238}U$ activity ratios, ranging in general from 1.9 to 2.8, were found in the water sources of the Lower Galilee, where there has been renewed active groundwater circulation both eastward and westward caused by the latest subsidence of the Jordan Rift Valley and the Mediterranean Young Pleistocene Sea Regression. These results point to the possibility that the mechanism of uranium isotope fractionation within this type of aquifer is basically governed by the solid rock-freshwater flow contact history. Further information gained by such studies might be useful in developing a better hydrogeological model for the groundwater flow regime within carbonate aquifers. (auth)

**19653** $^{39}Ar$ DATING OF GROUNDWATER. Oeschger, H.; Gugelmann, A.; Loosli, H.; Schotterer, U.; Siegenthaler, U.; Wiest, W. (Univ., Bern). pp 179-190 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The basic information for demonstrating the feasibility of an $^{39}Ar$ dating method is given. The present cosmic-ray-produced specific activity of $^{39}Ar$ in atmospheric argon is 0.112 ± 0.012 dpm/litre Ar. It can be assumed that this activity has been constant within a few per cents for the last thousand years. For possible man-made contributions from nuclear explosions and reactors in the period 1940 to 1973, an upper limit of 12% can be given. The $^{39}Ar$ dating method was successfully checked first by measuring argon extracted from polar ice samples of known age. The application of this method, together with $^{85}Kr$, $^{3}H$, and $^{14}C$ measurements, on groundwater has great value in isotope hydrology. A system which allows the extraction of the gases from 20 tonnes of water in about one day has been developed, and preliminary details of experiences with it are given. A procedure for the separation of argon and krypton from the extracted gases is described. The $^{39}Ar$ specific activity in the argon sample is measured in a low level counting system. Its background for a 1.8 litre argon (STP) gas sample is 0.27 counts/min and the modern net effect is 0.14 counts/min. Up to now only one $^{39}Ar$ age of water of a thermal spring in Zurzach, Switzerland, is available. From the $^{3}H$ result it can be concluded that the water is older than 50 years. The preliminary age information from $^{39}Ar$ (younger than 70 years) is in contradiction to the low specific $^{14}C$ activity of 12.4 pmc. Possible reasons for the discrepancy are discussed. (auth)

**19654** DISTRIBUTION OF SULPHUR ISOTOPES OF SULPHATES IN GROUNDWATERS FROM THE PRINCIPAL ARTESIAN AQUIFER OF FLORIDA AND THE EDWARDS AQUIFER OF TEXAS, UNITED STATES OF AMERICA. Rightmire, C. T. (Geological Survey, Reston, VA); Pearson, F. J. Jr.; Back, W.; Rye, R. O.; Hanshaw, B. B. pp 191-207 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

New information on the sources of sulphate dissolved in groundwater is obtainable from the measurement of the sulphur isotope composition of sulphates. Field studies in the Floridan aquifer,

Florida, and the Edwards aquifer, Texas, show that the use of sulphur isotope data in conjunction with hydrologic and geochemical techniques permits refinements of interpretation. In the Floridan the interpretation of the chemical data particularly the $SO_4^{2-}$ concentration and the $SO_4^{2-}/Cl^-$ ratio, leads to the conclusion that recharging maritime rainfall, solution of intraformational gypsum, and mixing with ocean-like saline waters are the sources of sulphate in the groundwater. Sulphur isotope data substantiate this interpretation. The Edwards in the area studied can be separated into two hydrologic units on the basis of water chemistry and aquifer characteristics. The sulphide-free waters in the part of the aquifer upgradient from a distinct sulphide boundary are low in sulphate (less than 100 mg/l) and contain no sulphide. The waters downgradient from that boundary contain greater than 150 mg/l sulphate and all contain measurable quantities of sulphide. Interpretation of the $SO_4^{2-}$ concentration and $SO_4^{2-}/Cl$ ratio on the basis of the Florida study leads to the erroneous conclusion that the solution of intraformational gypsum is again a major source of sulphate in the sulphide-free part of the aquifer. Isotope analyses, however, show that the gypsum is likely to be Permian in age and introduced into the aquifer by the recharge water. The absence of evidence for enrichment in $^{34}S$ in the sulphate in the sulphide-bearing portion of the aquifer leads to the possibility of $H_2S$ migration upgradient from downdip oil fields. (auth)

**19655** UTILIZATION OF NATURAL VARIATIONS IN THE ABUNDANCE OF NITROGEN-15 AS A TRACER IN HYDROGEOLOGY; INITIAL RESULTS. Letolle, R.; Mariotti, A. (Univ., Paris). pp 209-220 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In French)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Nitrogen compounds dissolved in natural waters exhibit considerable variations in nitrogen-15 content (more than 10‰). The analytical techniques used in measuring $\delta^{15}N$, the main features of the isotopic cycle of nitrogen, and the results obtained so far are described. A simplified model of the nitrogen cycle and its isotopic implications is presented; with this model one can deduce from a number of observed variations the physical or biological mechanism (or mechanisms) involved. Isotopic studies of nitrogen may be a useful additional tool for detecting and interpreting certain forms of pollution. (auth)

**19656** USE OF ISOTOPE TECHNIQUES TO SOLVE HYDROLOGICAL PROBLEMS IN CIVIL ENGINEERING: A STUDY OF THREE SPECIFIC CASES. Leveque, P. C.; Gros, J. C.; Maurin, C.; Severac, J.; Viguier, C. (Bordeaux Univ., Talence, France). pp 223-239 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In French).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Three examples of the use of natural and artificial radioisotopes are presented. The first relates to a study for a project involving civil engineering work beneath a built-up area. Investigations with tritium showed that the age of the water was variable and irregularly distributed within the acquifer; using natural $^{222}Rn$ and $^{82}Br$, it was possible to determine with a high degree of precision the location of permeable zones. The second example related to investigations with tritium and $^{82}Br$ which showed that the confined aquifer beneath an area where the construction of a large industrial complex is planned also consisted of units of different ages and that there was no substantial movement of water in the aquifer. The third example related to an earth dam in which natural tritium and $^{222}Rn$, and subsequently $^{82}Br$ and $^{131}I$ were used to study certain anomalies due to differences in the extent to which the earth had been packed. It was found that the permeability of the main body of the dam and its structural elements varied. A counter check based on the potential adsorption of $^{131}Cs + ^{131}Ba$ demonstrated the presence of granulometric heterogeneities, especially with regard to the fine argillaceous particles. (auth)

**19657** APPLICATION OF SINGLE BOREHOLE METHODS IN GROUNDWATER RESEARCH. Drost, W.; Neumaier, F. (Institut fuer Radiohydrometrie, Munich). pp 241-254 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Single borehole methods with improved instrumentation have been extensively and reliably used in the Federal Republic of Germany for various groundwater investigations. Useful experiences from measurements for about a hundred projects in more than a thousand boreholes in alluvial and karst aquifers during the last decade were obtained. While establishing the usefulness of single borehole methods, this report offers practical examples of investigations of groundwater exploitation, bank filtration, groundwater pollution as well as foundation and hydraulic engineering. (auth)

**19658** SIMPLIFIED MATHEMATICAL MODELS FOR INTERPRETING THE RESULTS OF TESTS CARRIED OUT BY LABELLING THE WHOLE PIEZOMETRIC COLUMN IN WATER WELLS. Munera, H. A. (Instituto de Asuntos Nucleares, Bogota). pp 255-275 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In Spanish)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Approximate methods used to interpret the results of tests based on radioactive tracer dilution in a single water well by labelling the whole piezometric column are described; these simple mathematical models have been used to obtain semi-quantitative data on the apparent velocity (horizontal) in non-homogeneous aquifers with flow rates of metres daily. Measurements have also been made in a homogeneous aquifer with velocities of centimetres daily. Interpretation is based on determination of the average concentration for the various well zones; this involves recognition of a mean velocity for each region. All the tracer dilution effects that are not due to horizontal or vertical flow between two zones, i.e. convection, artificial mixing, diffusion and so on, are grouped together as a single term, which is taken arbitrarily to be proportional to the difference in concentration between the regions under consideration; its value is obtained from the experimental dilution curve. The model was applied to the solution of the three cases encountered most frequently during our measurements in Colombia: (a) when the well penetrates a permeable zone and adjacent impermeable zone; (b) when the well penetrates a permeable zone contained between impermeable regions; and (c) when the well traverses an aquifer with two adjacent zones of different permeability contained between impermeable zones. The shape of the dilution curve (logarithm of concentration versus time, usually with two or more slopes) is predicted by the model, the approximate nature of which is consistent with the fact that the method of labelling the whole piezometric column is semi-quantitative. The results obtained for measurements made when there are considerable vertical flows are apparently correct, but there is no other experimental measurement available to confirm them. (auth)

**19659** THEORETICAL POSSIBILITIES OF THE TWO-WELL PULSE METHOD. Zuber, A. (Inst. of Nuclear Physics, Krakow). pp 277-294 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The problems of the determination of aquifer parameters by the two-well pulse method are described. This method involves an instantaneous injection of tracer in one well and the observation of its transit time to a pumping well. A recent solution of the dispersion equation is used for the theoretical description of the concentration curve measured in the pumping well. Characteristics of this solution are discussed as opposed to those of the commonly known solution. It is pointed out that only this new solution has its first moment, i.e. the mean arithmetic time, also called the centre of gravity, equal to the mean transit time of water. The conditions under which the first moment for a layered system represents the mean transit time of water are also discussed. This time can be found from experimental data either by calculating the first moment or by matching a theoretical curve. Other methods often applied such as time of the maximum concentration, and time of the half-width, can be accepted in approximations applicable only for slightly dispersed concentration curves. Interpretational methods for determining the parameters of particular layers in layered systems are reviewed in detail. These methods are based both on individual transit times and on relative recoveries. Under favorable conditions it is possible to find the mean effective porosity, hydraulic conductivities, and thicknesses of all the layers, and the mean thickness or diameter of fissures in fissured rocks. However, under unfavorable conditions it may be difficult to learn anything from a tracer experiment. (auth)

**19660** DETERMINATION OF EFFECTIVE POROSITIES BY THE TWO-WELL PULSE METHOD. Kreft, A. (Inst. of Nuclear Physics and Techniques, Krakow); Lenda, A.; Turek, B.; Zuber, A.; Czauderna, K. pp 295-312 of Isotope Techniques

in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Results obtained in the use of the two-well pulse method in fissured and granular media are presented. The measurements in the former were aimed mainly at obtaining the effective porosity of Zn-Pb and sulphur deposits in limestone and dolomite formations. Breakthrough curves obtained in these fissured and cavernous formations appeared to be rather regular though highly asymmetrical, due to a high dispersion. Both manual and computer interpretations have been developed on the basis of a new, analytical solution of the dispersion equation. This solution is exact in a unidimensional flow, and approximate in a radial flow. The manual interpretation is based on an assumption of equal surfaces under both theoretical and experimental curves and fitting at a guess, whereas the computer interpretation is based on minimizing the chi-squared value. Some experiments could be interpreted only under an assumption of a breakthrough curve consisting of two or more component breakthrough curves. However, the interpretation is not always unambiguous because in cases of a high dispersion the tail part of the breakthrough curve is seldom measurable. In granular media of fluvial and fluvio-glacial origin usually irregular, though less dispersed, curves were observed. Their interpretation was performed either by a rough approximation or by calculating the mean arithmetic time as the ratio of the first to zero moments. (auth)

**19661** INVESTIGATIONS OF EFFECTIVE POROSITY OF TILL BY MEANS OF A COMBINED SOIL-MOISTURE/DENSITY GAUGE. Nordberg, L.; Modig, S. (Geological Survey of Sweden, Stockholm). pp 313-340 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Effective porosity and processes of saturation and dewatering in till have been investigated. The study was performed in undisturbed till columns, surrounded by ring-shaped excavations filled with sand. The procedure allowed for a raising and lowering of an artificial groundwater level in the till under controlled conditions, which in turn made possible controlled processes of saturation and dewatering. A combined gamma-neutron soil moisture/density gauge was used. The water content was recorded during a period in which water was added to a specially prepared, undisturbed in-situ soil column until a state of saturation was reached. This was followed by a period of induced dewatering by gravity drainage. The drainage was recorded until a steady state, approximately equalling field capacity, was approached (5 to 16 d). Water contents at saturation are assumed approximately to equal total porosity, having a range of 17.9 to 32.0% in the investigated till. The intensity of drainage was highest on the first day of dewatering and then diminished with time. A perfectly steady state was never reached. Therefore field capacity is used with indices, indicating the length of time of drainage. Consequently, effective porosity is qualified by the corresponding indices. After 15 to 16 days of gravity drainage, effective porosity was calculated to be on the average 7.4% at one test plot and 3.4% at another. The difference has been attributed to a corresponding difference in depth to the natural groundwater level; because of the method used a higher groundwater level and capillary fringe may have hampered the complete drainage, resulting in a relatively low value of effective porosity. The investigation is most likely to be applicable in water balance studies, groundwater discharge predictions, and various construction and waste-water projects in moraine terrain. (auth)

**19662** HYRODYNAMIC DISPERSION AS AQUIFER CHARACTERISTIC: MODEL EXPERIMENTS WITH RADIOACTIVE TRACERS. Klotz, D.; Moser, H. (Institut fuer Radiohydrometrie, Munich). pp 341-355 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

About 2500 dispersion tests using radioactive, salt and dye tracers were performed on column devices of varying diameter and different lengths to determine the dependence of the longitudinal dispersion coefficient on the parameters of the streaming fluid and on the characteristics of the porous medium. Artificial and natural materials were employed differing in grain size, grain shape, grain roughness and angularity, compactness, and having various uniformity coefficients of grain-size distribution. The study generally confirmed the approximately linear relation between dispersion coefficient and distance velocity found in the literature for special conditions. In addition it appeared that in particular the grain size and uniformity coefficient of grain-size distribution substantially affect dispersion, and other parameters also enter into the dispersion coefficient. It is concluded that the dispersion coefficient is a characteristic quantity independent of permeability which in turn describes the phenomena of tracer spread in aquifers. (auth)

**19663** RADIOISOTOPE STUDIES OF MOLECULAR AND CONVECTIVE DIFFUSION IN SATURATED AND NON-SATURATED (SAND-CLAY) ROCK. Dubinchuk, V. T.; Kolesnichenko, Z. G.; Lapteva, O. F.; Goncharov, V. S. (All-Union Scientific Research Inst. of Hydraulic Engineering Geology, Moscow). pp 359-375 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In Russian)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The theoretical, technical, and methodological aspects of experimental determinations of the characteristics of diffusional transfer of sodium chloride in sand-clay rock are discussed. Knowledge of these characteristics is a prerequisite for the solution of problems relating to the formation and chemical composition of groundwater and interstitial solutions, to applications of hydrogeology in reclamation work and to the efficient use of groundwater and its protection from pollution. Laboratory procedures involving the use of gamma tracers, and more particularly sodium-22, have been developed and tested for studying molecular and convective diffusion in saturated and non-saturated sand-clay rock. Algorithms are discussed for processing the experimental data, taking into consideration methods of successive layers and of open and closed diffusion columns as well as techniques based on non-destructive measurement with collimators. An alternative method is described for field determination of diffusion parameters, developed during the complex hydrogeological survey of territory in the Transvolga steppe that it is proposed to irrigate. A number of unsolved problems requiring more detailed theoretical and methodological study are formulated, more particularly calculation of diffusion characteristics for processes which involve several diffusion mechanisms. Radioisotope methods, which can now be considered as fully developed, make it possible to formulate and, in the very near future, to solve the problem of determining the diffusional transfer characteristics of the main components of groundwater and interstitial water mineralization for the case of typical rock, as a function of such basic conditions as humidity and temperature. As an example of this work, the paper presents the results of some sodium-22 determinations of sodium chloride diffusion. (auth)

**19664** ANALYSIS OF INFORMATION PROVIDED BY NATURAL OR ARTIFICIAL TRACERS USED TO STUDY AQUIFER SYSTEMS IN HYDROGEOLOGY. Guizerix, J. (CEN, Grenoble France); Margrita, R.; Gaillard, B.; Corompt, P.; Alquier, M. pp 377-404 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In French)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

After referring to the use of the transfer function method in the analysis of multivariable linear systems, the authors discuss-on the basis of standard examples-the use of residence time distributions, which are a fundamental kind of information provided by tracers. Measurement of flow rates by Allen's classical method is the first example and illustrates, for confined flows, the method of analysing multivariable systems. The authors examine the conditions for employing this method and introduce the property of pulse response identity, the practical significance of which is considerable. This property, which is established by representing the flow by a Markov chain, is extended to underground flows. In another example, the authors analyse the problem of water transfer between two boreholes. Lastly, they deal with two important sampling problems involving residence time distributions: the dating of water and the study of the kinetics of interactions between pollutants and the medium during their transfer (self-purification). (auth)

**19665** METHOD FOR DETERMINING THE CHARACTERISTICS OF POLLUTANT TRANSFER IN AQUIFERS. Corompt, P. (CEN, Grenoble, France); Gaillard, B.; Guizerix, J.; Margrita, R.; Molinari, J.; Corda, R.; Crampon, N.; Olivier, D. pp 405-424 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974). (In French)

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The problems considered relate mainly to the definition of perimeters for the purpose of protecting underground water catchment areas. Use is made of a transition analysis method involving the pulse responses between two (or n) boreholes of a good tracer, the object being to determine minimum pollutant transfer times. Special attention is paid to the linearity conditions of the system, the representativeness of the ground samples between the boreholes, the signals received in the boreholes and transverse dispersion. It is established that the isochronism and isomorphism of the pulse responses relative to boreholes located in a plane perpendicular to the flow lines are of considerable practical significance. Examples drawn from current studies are presented. (auth)

**19666** SOME CONCEPTUAL MATHEMATICAL MODELS AND DIGITAL SIMULATION APPROACH IN THE USE OF TRACERS IN HYDROLOGICAL SYSTEMS. Przewlocki, K.; Yurtsever, Y. (International Atomic Energy Agency, Vienna). pp 425-450 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

The use of multi-cell models and of recursive equations based on mass-transport for interpretation of isotopic data in hydrologic systems is discussed with particular emphasis on groundwater aquifers. The effects of both geometry and recharge pattern on the behavior of aquifers in a tracer case are studied. The digital simulation with multi-cells in series is applied to actual tritium data from two projects. (auth)

**19667** APPLICATION OF DIGITAL MODELLING TO THE PREDICTION OF RADIOISOTOPE MIGRATION IN GROUNDWATER. Robertson, J. B. (Geological Survey, Idaho Falls, Idaho). pp 451-478 of Isotope Techniques in Groundwater Hydrology. Vol. II. Vienna; International Atomic Energy Agency (1974).

From symposium on isotope techniques in groundwater hydrology; Vienna, Austria (11 Mar 1974). See STI/PUB-373(Vol.2); CONF-740312-P2.

Recently developed numerical techniques have been adapted to the solution of transient radioactive solute migration problems in groundwater. The differential equations of groundwater movement are first solved by standard finite difference methods, then the differential equations of solute transport are solved by the method of characteristics. Validity of the simulation techniques is demonstrated for real examples of tritium, chloride, and $^{90}Sr$ migration of groundwater at the National Reactor Testing Station, Idaho. This is probably the first documented field-verification of such a model that includes the effects of convective transport, two-dimensional dispersion, radioactive decay, and ion exchange. Model results demonstrate the relative sensitivity of groundwater transport systems to various parameters, such as dispersion coefficients and ion-exchange distribution coefficients. The models can be very useful in predicting the behavior of natural isotopes, artificial tracers, or waste in groundwater. The models allow variable hydraulic parameters in space and time, as well as variable chemical parameters. Predictive use of such models is demonstrated for several different conditions in a heterogeneous basaltic aquifer. Thirty-year predictions of tritium and $^{90}Sr$ migrations are shown with variable hydraulic and chemical influences. Additional methods and potential applications of modelling are suggested, including tracer migration studies and natural isotope distributions in groundwater. (auth)

**19668** MATHEMATICAL MODELS, BASED ON DIFFUSION EQUATIONS, TO DESCRIBE ROOT SYSTEMS OF ISOLATED PLANTS, ROW CROPS, AND SWARDS. Page, E. R.; Gerwitz, A. (National Vegetable Research Station, Warwick, Eng.). Plant Soil; 41: No. 2, 243-254(Oct 1974).

Mathematical models to describe the density of plant roots in the soil were developed by analogy from the equations describing diffusion or heat flow. Results from an experiment with isolated plants (lettuces) shows that the equation for diffusion from a point source applies, while results from a row crop (onions) indicate that when allowance is made for the asymetry resulting from a preferred direction of growth, the equation describing diffusion from a line into a semi-infinite medium can be applied. Results reported by other workers for ryegrass are used to demonstrate that for a sward the appropriate equation is that describing diffusion from a plane into a semi-infinite medium. In this case the mathematical model renders a means of interpreting the results of a nuclear tracer technique. (NL)

**19669** QUANTITATIVE ENRICHMENT OF $^{14}CH_4$ WITH THE CLUSIUS-DICKEL SEPARATION TUBE APPLIED TO $^{14}C$ DATING. Kretner, R. (Muenchen Univ. (F. R. Germany). Physikalisch-Chemisches Inst.). Z. Phys. Chem. (Frankfurt); 87: No. 4/6, 284-287(Dec 1973). (In German).

Due to the small specific activity of recent carbon of 13.6 cpm/g and the half-life of $^{14}C$ of 5,700 years, the application range of the $^{14}C$ dating is limited to a maximum of 60,000 years. In order to extend this space of time, a method was found with which the $^{14}CH_4$ can be quantitatively enriched by at least a factor of 8 corresponding to three half-lives. (GE)

## Site Surveys

*Refer also to abstracts 19557, 19562, and 19569.*

**19670** (NP-20308) SITING OF NUCLEAR POWER PLANT IN THE OSLOFJORD DISTRICT. Report From Group 1: Technical/Economic Evaluation of Proposed Sites. (Norges Vassdrags- og Elektrisitetsvesen, Oslo. Direktoratet for Statskraftverkene). [nd]. 74p. (In Norwegian). Dep. NTIS (US Sales Only) $6.75.

A large number of possible sites for nuclear power plants in the Oslofjord district have been selected on the basis of given criteria. Group 1 has had the task of assessing these sites from the economic viewpoint, including the cost of access roads, fresh water supplies, power lines, etc. as well as the civil engineering costs of site excavation and landscaping for both surface and underground plants. Specified costs for all prospective sites are presented. (NO)

**19671** (RLO-2225-T18-8) POLONIUM-210 AND PLUTONIUM-239, 240 IN BIOLOGICAL SAMPLES OF BIKINI AND ENIWETOK ATOLL WATERS. Nevissi, A.; Schell, W. R. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). Jun 1974. Contract AT(45-1)-2225. 21p. Dep. NTIS $4.25.

The available data on the important problem of $\alpha$-emitting radionuclides in marine organisms is limited. In the nuclear testing area of Bikini and Eniwetok Atolls the concentrations of Po and Pu in sediments, water, and biota have been measured. This isolated area of the Central Pacific provides an almost ideal environmental laboratory for investigation of the radionuclides in the marine environment and their uptake by biota. Biological species, mainly non-migratory and thus local feeders, were collected from the intertidal zone at different locations; water samples were taken near the areas of the biological stations of both Bikini and Eniwetok Lagoons. After dissolution and radiochemical separations, Po and Pu were plated and measured by $\alpha$ spectrometry. The results show that the specific activities of $^{210}Po$, $^{239}Pu$, and $^{240}Pu$ in biota range from 0.1 to 10 dpm/g and 0.002 to 5 dpm/g, respectively. The $^{210}Po$ activity is consistently higher than the Pu activity by factors of 1 to 200 in the species measured. The physical-chemical states of $^{210}Po$, $^{239}Pu$, and $^{240}Pu$, the uptake by biota, and the concentration ratios from water to biota were determined for these radionuclides. (auth)

**19672** (RLO-2225-T18-10) CONCENTRATIONS AND PHYSICAL-CHEMICAL STATES OF RADIONUCLIDES IN BIKINI ATOLL LAGOON WATER. Schell, W. R. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). Jun 1974. Contract AT(45-1)-2225. 50p. Dep. NTIS $5.50.

A subject of increasing interest and concern is the introduction of large amounts of radionuclides and trace metals into the marine environment from nuclear detonations, power reactors, and from man's other technological developments. The physical-chemical states of radionuclides and trace metals in the marine environment are of fundamental importance to their uptake by organisms. Information pertinent to this problem is minimal for several reasons, including difficulties in sampling. The present study utilized a unique collector to process 2000 to 4000 liters of water and separates particulates of 0.3 $\mu$m and soluble fractions during collection. The concentration of certain long-lived radionuclides still remaining at Bikini and Eniwetok Atolls is sufficient to provide a natural marine environment to test the collection and physical-chemical states. Results are reported for $^{155}Eu$, $^{207}Bi$, $^{60}Co$, $^{55}Fe$, $^{238}U$, $^{241}Am$, and $^{239,240}Pu$ measured in Bikini Lagoon sediments and waters. (auth)

**19673** (RLO-2225-T18-12 and App.) DISTRIBUTION OF ALPHA EMITTING RADIONUCLIDES IN SEDIMENTS OF BIKINI ATOLL LAGOON. Marshall, R. P.; Schell, W. R. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). 26 Jun 1974. Contract AT(45-1)-2225. 53p. Dep. NTIS $5.75.

Between 1946 and 1958 Bikini Atoll in the northern Marshall Islands was the site of some 23 atomic and thermonuclear tests. During that period, and since, several studies of the levels, distributions, and impact of the fission product radionuclides introduced at Bikini and other environments were conducted.

There has, however, been little data published on the levels and distribution at Bikini Atoll of the parent fissile materials of uranium and plutonium. This study reports on the concentrations of naturally occurring $\alpha$ emitters and the distribution of $^{238}Pu$, $^{239}Pu$, $^{240}Pu$, and $^{241}Am$ in surface samples and cores of Bikini Lagoon sediments analyzed to date. The use of isotope activity ratios to trace the origin of specific sedimentary debris are presented. The regions of highest surface activity lie considerably downstream from the major crater areas. These regions are also much larger in area than the craters and therefore are considered the major sources of radionuclides available for redistribution. Activity profiles in cores show that several cm of coralline deposits of high specific activity exist in lagoon sediments. Further, the radionuclides are still present in the water column indicating continuous redistribution. (auth)

**19674** (RLO-2225-T18-14) STUDIES OF CONCENTRATIONS OF UNREPORTED LONG-LIVED RADIONUCLIDES IN BIOTA AND OCEAN SEDIMENTS AT BIKINI AND ENIWETOK ATOLLS. Annual Progress Report, 1973–1974. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). 1974. 10p. Dep. NTIS $4.00.

Interest in the radiological environment at Bikini and Eniwetok Atolls has increased due to their imminent resettlement by their Marshallese owners. A search was made for the presence of previously unidentified radionuclides still remaining from the testing of nuclear weapons. Aluminum-26 was detected in some environmental samples by $\gamma$-ray spectroscopy. A large-volume water sampler and sorption beds were used to prepare samples of seawater for analysis. Bomb-produced $^{241}Am$, $^{239}Pu$, and $^{240}Pu$, and natural $^{210}Po$ were found in samples of sediment and marine biota. A list of published papers is included that report the results in detail. (CH)

**19675** (UCID–16663) TECHNIQUE TO ENHANCE CRACK GROWTH AND INCREASE PERMEABILITY IN GEOLOGICAL MEDIA. Glenn, H. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Jan 1975. Contract W-7405-Eng-48. 10p. Dep. NTIS $4.00.

Results from a series of high explosive tests in Playa alluvium at the Nevada Test Site are examined. Based on these results, an explosive fracture technique (using high explosives and rocket propellant) is proposed to enhance crack growth and increase the permeability of geological media. Late-time cavity gases provided by the propellant should sustain crack growth. Five experiments are designed to further explore the technique. (auth)

**19676** (UCRL-76436) EVALUATION OF PLUTONIUM AT ENEWETAK ATOLL. Wilson, D. W.; Ng, Y. C.; Robison, W. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1975. 39p. (CONF-740550-4). Dep. NTIS $5.00.

From 2nd annual life sciences symposium on plutonium - health implications for man; Los Alamos, New Mexico, USA (22 May 1974).

An extensive survey was carried out in 1972 to 1973 to assess the current radiological status of Enewetak Atoll. The radionuclides detected in the Atoll environment were studied for their potential contributions to the dose commitment of the returning population according to several pathways of exposure. Plutonium-239 and $^{240}Pu$ were detected in air and in the terrestrial and aquatic environment at concentrations that varied from background levels due to world-wide fallout to levels several orders-of-magnitude above. The dose commitments from plutonium via the terrestrial food chain and inhalation vary according to the postulated living pattern. The dosages via marine foods can be expected to be insensitive to living pattern and to exceed those via terrestrial foods. Plutonium would contribute nearly all of the dosage via inhalation, but this pathway ranks low in overall importance compared with the food-chain and external-dose pathways. Although the potential dose from plutonium via all pathways is low relative to that from $^{60}Co$, $^{90}Sr$, and $^{137}Cs$, plutonium will still remain in the Atoll environment after the other major isotopes have decayed away. (auth)

**19677** PROGRAM OF ENVIRONMENTAL INVESTIGATIONS FOR THE INSTALLATION ON THE TOSCO-EMILIAN APENNINE OF A 140 MW FAST REACTOR. Benfenati, I.; Buttol, B.; Cazzoli, S.; Cervellati, A.; D'Orazi, R. (CNEN, Bologna). G. Fis. Sanit. Prot. Radiaz.; 17: No. 3-4, 113-118(1973). (In Italian).

The program of environmental investigations carried on at the Brasimone area, on the Tosco-Emilian Apennine, chosen to be the site of the experimental fast reactor PEC is presented. The program is analyzed in detail in its parts: hydrogeology, meteorology, radioecology, giving of each of them the up to date situation and the lines according to which they will be developed in the future in order to obtain information as complete and deep as possible on the site under examination. (auth)

**19678** RADIOECOLOGICAL SURVEY ON THE SITE OF BRASIMONE LAKE (APPENNINI MOUNTAINS). Antonelli, A. (CNEN, Rome); Bombace, M. A.; Cervellati, A.; Cigna Rossi, L. G. Fis. Sanit. Prot. Radiaz.; 17: No. 3-4, 103-112(1973). (In Italian).

The first results of an environmental survey on the site of an experimental fast reactor (PEC) near the Brasimone Lake, in the Tosco-Emilian Appennini Mountains, are exposed. The study is oriented by the peculiar characteristics both of the site and of the nuclear plant. Indeed, the area defined by atmospheric diffusion data does not coincide with the liquid radioactive waste diffusion area. The fate of liquid wastes is linked to natural waters flow from the Brasimone Lake towards the Reno River, in the South to North direction. The interlinked problems of different critical pathways (drinking water; edible fishes and/or contamined vegetables) are discussed. Particularly important under the psychological point of view is the existence of a relevant critical population group exposed to the drinking water pathway in the Bologna's area. The foreseable contamination levels are confined among the least measurable values, which are rarely observed, only referring to very unlikely hydraulic conditions. (auth)

**19679** ATMOSPHERIC DIFFUSION CALCULATION, WITH INCLUSION OF CONDITION STABILITY FREQUENCIES AND THE CLIMATOLOGICAL MATRIX ELEMENTS FOR CNR TRISAIA SITE. Cassano, G.; Fraschetti, G.; Siciliano, F. (CNEN, Policoro, Italy). G. Fis. Sanit. Prot. Radiaz.; 17: No. 3-4, 80-102(1973). (In Italian).

Results of the calculation of the atmospheric diffusion concerning the radioactive airborne materials released from 60 m. C.R.N. Trisaia stack are reported. With Meade and Pasquill formulas including local parameters as the frequencies $p_j$ of Pasquill stability categories and the elements $q_{ij}$ of climatological matrix $Q_{ij}$ the calculation was performed with the aid of CICWD2, an ad hoc code written in FORTRAN IV language for 370/75-IBM computer. The good features of atmospheric dispersion of Trisaia site are emphasized from both geographic and demographic considerations and performed results examination. (auth)

**19680** GEOTHERMICS, WITH SPECIAL REFERENCE TO APPLICATION. Kappelmeyer, O.; Haenel, R. Geoexploration Monographs, Series 1, No. 4. Berlin; Gebrueder Borntraeger (1974). 250p.

The subject of geothermics is of interest in relation to its application to geothermal prospecting and in relation to the thermal anomalies associated with the underground storage of radioactive wastes. Theoretical and practical aspects of the subject are discussed in the book under the following headings: fundamental concept of heat transfer; thermal conditions of the earth's interior; thermal conditions of the earth's crust; practical applications of geothermics; and geothermal investigations in deep wells. Eight tables are appended as are a bibliography and subject index. (ERB)

## Thermal Effluents

*Refer also to abstracts 19558, 19559, 19584, and 21829.*

**19681** (EPA-660/3-74-014) STUDIES OF EFFECTS OF THERMAL POLLUTION IN BISCAYNE BAY, FLORIDA. Roessler, M. A.; Tabb, D. C. (Miami Univ., Fla. (USA). Rosenstiel School of Marine and Atmospheric Sciences). Aug 1974. 147p. GPO $2.25.

Field studies on the effects of thermal additions from the Florida Power & Light Company's discharge at Turkey Point have been conducted to determine the effects of this effluent on the macroinvertebrates and fishes of the area. Replicate samples with a 3 m (10 foot) otter trawl lined with .63 mm ($\frac{1}{4}$ in.) bar mesh were made monthly at 20 stations. Data on temperature, salinity, and oxygen were collected during each sampling period. Additional chemical data were collected when opportunity existed. The experimental results suggest that maximum summer temperatures above 32°C cause detrimental changes in the environment which are reversible in the winter while temperatures above 33°C cause damage which does not recover during the cooler months. Intermittent flow of discharge water is not as damaging as constant flow. Card Sound appears to be as productive as Biscayne Bay and temperatures exceeding 33°C will also cause damage in Card Sound. (auth)

**19682** (PB-223350) SELECTED ANNOTATED BIBLIOGRAPHY ON WATER RESOURCES OF THE STATE OF WASHINGTON. (Washington State Dept. of Ecology, Olympia (USA)). 1973. 553p. (WRIS-INFO-BULL-7). NTIS $10.50.

The bibliography containing 340 abstracts was produced by the Water Resources Scientific Information Center from its information base comprising Selected Water Resources Abstracts (SWRA). At the time of search for this bibliography, the data base had 50,631 abstracts covering SWRA through December, 1972 (Volume 5, Number 24). Author and Subject Indexes are included. (GRA)

**19683** (PRWG-105-1) EFFECTS OF TEMPERATURE ON THE TOXICITY TO THE AQUATIC BIOTA OF WASTE DISCHARGES: A COMPILATION OF THE LITERATURE. Middlebrooks, E. J.; Gaspar, M. J.; Gaspar, R. D.; Reynolds, J. H.; Porcella, D. B. (Utah State Univ., Logan (USA). Utah Water Research Lab.). Oct 1973. 170p. Utah State Univ., Logan.

An extensive compilation and general evaluation of the literature on thermal pollution of aquatic ecosystems is presented which describes the temperature interaction with toxicity. Recent literature is summarized and made accessible along with a few generalized relationships such that researchers may design studies in a manner that will increase the utility of their results. A detailed indexing system is employed which makes the information contained in the report accessible by author, toxicant, and test organism. Summary tables of the most pertinent literature are also presented for easy subject retrieval. (1289 references) (CH)

**19684** THE POLLUTION OF THE WATERS AND THEIR CAPACITY FOR WASTE HEAT ABSORPTION. Koppe, P. (Ruhrverband und Ruhrtalsperrenverein, Essen (F. R. Germany)). Brennst.-Waerme-Kraft; 26: No. 9, 380(Sep 1974). (In German).

The useful and harmful effects of waste heat, which enters surface waters with the cooling water, depends to a great extent on the content of contaminants in the water. This is especially true with regard to the effects on the oxygen balance and the organic entity of a water system, but also regarding drinking water supply from surface waters. The higher the concentration of contaminants, the lower is the admissible maximum temperature and the temperature to be fixed. The thermal pollution of many rivers with respect of cooling requirements in power stations is already so high that the capacity for waste heat absorption in the rivers is practically exhausted, even if all the waste waters admitted are extensively cleaned. (auth)

**19685** INFLUENCE OF HEATED DISCHARGE WATERS FROM THE SKAWINA ELECTRIC POWER STATION ON THE ICHTHYOFAUNA OF THE RIVERS SKAWINKA AND VISTULA. Epler, P.; Bieniarz, K. (Instytut Zoologii Stosowanej, Krakow). Acta Hydrobiol.; 15: No. 3, 1-10(1973).

Investigations on the influence of heated waste waters discharged into the Skawinka and Vistula rivers showed that, except for the hottest seasons of the year, fish gather in the area of heated waters. In high water temperatures (20 and 28°C for unheated and heated waters, respectively), the total amount of fish caught decreased. Species such as Leuciscus cephalus, Alburnus alburnus, Barbus barbus, and L. leuciscus were highly eurythermic. (Pollut. Abstr.)

**19686** HEAT BALANCE AND EVAPORATION IN THERMALLY POLLUTED STREAMS. Jaworski, J. (Wasserwirtschaft; 63: No. 4, 105-110(Apr 1973). (In German).

Results of theoretical and practical investigations are presented, concerning the differentiation in time and space of heat balance components and evaporation of a thermally polluted river in Poland. The discharges of heated water resulted in a considerable increase of the river evaporation and affected nearly all the individual heat balance components. The yearly evaporation from the thermally polluted river was 1.5 to 3 times higher than under natural conditions. The cooling of the river is mainly caused by heat losses during the evaporation and convection processes. Radiation balance takes part in the cooling processes only from Oct. to Feb. Maximum values of daily effective heat losses from the river surface into the atmosphere oscillate between 406 $W/m^2$ (DH section) and 696 $W/m^2$ (UZ zone) and are similar to values at Goldberger Lake. (Pollut. Abstr.)

**19687** OPTIMAL PLANNING FOR A THERMAL DISCHARGE TREATMENT SYSTEM. Dracup, J. A. (Univ. of California, Los Angeles). Water Resour. Res.; 10: No. 1, 67-71(Feb 1974).

The characteristics and economic implications of thermal pollution are considered the planning of a treatment system for a series of hypothetical nuclear power plants located adjacent to a river. These power plants are assumed to discharge sufficient heated cooling water to make treatment facilities necessary. Optimal planning of a treatment system is required to minimize the total annual cost for the construction and operation of the entire system. The constraint on this minimization process is not to violate a maximum temperature requirement within each section of the river. The problem is solved by a bypass-piping system. The technique of bypass piping consists of piping waste water downstream to sections of a river where the regenerative powers of the physical system have reduced the level of pollution so that more waste water may be disposed, and allows the beginning and end temperatures of a section of the river to be controlled. A procedure can be developed for separating the optimization model of the entire system. This model is separated into a set of small subproblems that are solved by simulation and a system problem that is solved by dynamic programming. The bypass-piping system significantly reduces the cost of the entire treatment system. (Pollut. Abstr.)

## Chemical Effluents

*Refer also to absiracts 19259, 19260, 19578, and 19597.*

# INSTRUMENTATION

## Radiation Detection Instruments

*Refer also to abstract 20546.*

### General Detectors and Monitors

*Refer also to abstracts 19769, 20507, and 21443.*

**19688** (AD-782810) IONIZATION DETECTOR SYSTEM. Final Report, 9 June 1972-9 August 1973. Schluter, B. C.; Anderson, W. E. (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Div.). Sep 1973. Contract DAAA15-72-C-0335. 159p. NTIS $11.00.

The work described covers the period from 9 June 1972 to 9 August 1973 for studies and design changes aimed at improving the ionization detector system overall performance capability. This report outlines the program approach, the system design changes, results of the studies and performance data for the three modified systems. The ionization detector system performance was improved by increased reliability, improved cells, improved calibration features, improved performance and a modified inlet system. Other design changes include the use of improved O rings, rotating the fuse for better access, changing to heavy duty connectors, and improvements in the design of the surface contamination module. (auth)

**19689** (AD-784812) LIQUID SCINTILLATION COUNTING OF NEUTRON ACTIVATED FOILS. Final Report. Wailly, L. F.; Watters, J. W.; Carter, P. B. (Air Force Academy, Colo. (USA)). Jul 1974. 16p. (USAFA-TR-74-15). NTIS $3.00.

Aluminum, gold, and copper foils were activated by a broad spectrum low intensity neutron beam. The foils were immersed in scintillating fluors and activity determinations were made using a coincident type photomultiplier system. The relative efficiencies for four counting geometries were considered and the most effective geometry was found to be with the foil to be placed in a horizontal position at mid-depth in the fluor. The relative effectiveness of different scientillation fluors varied according to the energy distribution of radiations being measured. (auth)

**19690** (BNL-19487) TWO-DIMENSIONAL POSITION-SENSITIVE DETECTOR FOR THERMAL NEUTRONS. Alberi, J.; Fischer, J.; Radeka, V.; Rogers, L. C.; Schoenborn, B. (Brookhaven National Lab., Upton, N. Y. (USA)). Dec 1974. 25p. (CONF-741213-11; CONF-741212-11). Dep. NTIS $4.25.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

A thermal neutron, two-dimensional position-sensitive detector was developed and tested for use in neutron scattering from biological samples. The detector is based on a multiwire proportional concept with a gas filling of 6 atm $^3$He, 4 atm A, and 0.5 atm $CO_2$. The position readout uses a resistive wire with charge division to determine position. A resolution of less than 3 mm (FWHM) was measured with a detection efficiency of 70% at 2.8 Å neutrons. Considerations leading to an optimal configuration are discussed. (auth)

**19691** (BNWL-SA-5232) RECENT ADVANCES IN GAS SCINTILLATION PROPORTIONAL COUNTERS. Palmer, H. E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1974. 18p. (CONF-741213-5). Dep. NTIS $4.00.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

Various geometrical configurations for gas scintillation proportional counters have been investigated in order to determine which is best for use in a large volume, high efficiency counter for measuring low energy gamma and x-rays. A xenon-filled counter having a rod anode inside a cylindrical cathode appears to provide the best configuration for providing a uniform field and the best resolution over the total volume of the counter. The details of construction and operating characteristics of various shaped counters are described. (auth)

**19692** (CISE-N-169) BETA AND GAMMA DETECTION EFFICIENCIES FOR SOME TYPICAL RADIONUCLIDES IN SOURCES OF DIFFERENT MATRIX AND GEOMETRY. Bonfanti, G.; Triulzi, C. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct 1974. 34p. Dep. NTIS (US Sales Only) $4.75.

Beta detection efficiency curves are reported for some radionuclides of interest contained in sources of definite chemical form and having different thicknesses. The curves were experimentally drawn measuring the reference sources with two end window GM detectors, and by an anticoincidence GM counter. The report also presents a set of gamma detection efficiency data as a function of energy obtained by $2'' \times 2''$ and $3'' \times 3''$ NaI (Tl) crystals and by 50 cm$^3$ Ge (Li) detector. Different source matrices (water, sediment, fallout residue, specific salts) and geometries were considered. (auth)

**19693** (LBL-3047) CODED APERTURE IMAGING OF GAMMA-RAYS USING MULTIPLE PINHOLE ARRAYS AND MULTIWIRE PROPORTIONAL CHAMBER DETECTOR. Chang, L. T.; Macdonald, B.; Perez-Mendez, V.; Shiraishi, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 6p. (CONF-741213-8). Dep. NTIS $4.00.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

Coded shadows of gamma-ray distributions have been made using both random pinhole and non-redundant pinhole coded apertures with a multiwire proportional chamber as detector. Image reconstruction is done optically with incoherent light. Lateral and depth resolution results are presented and calculations of background and signal to noise ratios for the nonredundant aperture are made and compared with the single pinhole collimator. (auth)

**19694** (LBL-3630) LITHIUM-DIFFUSED $n^+$ CONTACTS ON HIGH-PURITY GERMANIUM: HOW THIN CAN THEY BE MADE; HOW STABLE ARE THEY? Pehl, R. H.; Cordi, R. C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 4p. (CONF-741213-9). Dep. NTIS $4.00.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

A Li-diffused $n^+$ surface layer is the best $n^+$ contact developed up to the present time. However, the effective dead layer resulting from the Li-diffusion prevents the optimum stacking of detectors for counter telescopes. Diffusion temperatures as low as 160°C have been successfully used to produce effective dead layers as thin as 10 $\mu$. Unfortunately, these dead layers increase significantly when the detector is annealed following radiation damage. (auth)

**19695** (LBL-3631) EFFECT OF IMPROVING ENERGY RESOLUTION ON GAMMA CAMERA PERFORMANCE: A QUANTITATIVE ANALYSIS. Llacer, J.; Graham, L. S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 43p. (CONF-741213-13). Dep. NTIS $5.25.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

The Modulation Transfer Functions (MTF) of two commercial cameras and of a single element germanium camera fitted with different collimator configurations have been studied theoretically and experimentally in order to separate the different elements which contribute to the imaging capabilities of a gamma camera. Effects due to size and shape of collimator holes, and to positron range at 511 keV have been treated as filtering functions, predicting the behavior of a camera quite accurately. The effect of energy resolution has then been studied by noting the changes in MTF and the corresponding changes in the computer generated image of a low contrast circularly symmetric phantom as a function of energy resolution. The possibility of excellent imaging under low contrast situations with high-energy resolution detectors is demonstrated, and the required penalty in camera speed is documented. (auth)

**19696** (ORO-2843-24) DEVELOPMENT AND APPLICATIONS OF THIN FILM DETECTORS. Progress Report, January 1, 1974-December 31, 1974. Muga, M. L. (Florida Univ., Gainesville (USA)). 1974. Contract AT(40-1)-2843. 136p. Dep. NTIS $10.00.

Separate abstracts were prepared for the 9 papers presented. (WHK)

*For abstracts of individual papers see: 19697-19700, 21237-21240, and 21276.*

**19697** (ORO-2843-24, pp vp) REFINED MODEL OF LUMINESCENCE PRODUCTION IN PLASTIC SCINTILLATORS. Muga, L.; Diksic, M. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

Refinement is made of a previously reported model describing the specific luminescence of plastic scintillators when penetrated by energetic heavy ions. A detailed description of the model is given and simplifying assumptions on which it is based are discussed. Appropriate relations are derived which describe the

scattered electron density profile along the path of the moving heavy-ion. Comparison of results with those of the original model is shown. The concept of saturation of luminescence centers leads to an explicit relation from which relative specific luminescence data may be calculated. An additional empirical correction provides calculated specific luminescence values that are in remarkable good agreement with experimental data. Figures of calculated and experimental values of specific luminescence are shown for $^{16}O$, $^{35}Cl$, $^{40}Ar$, $^{79}Br$, and $^{127}I$ ions over an energy range from less than 10 MeV to about 140 MeV. (auth)

**19698** (ORO-2843-24, pp vp) RESPONSE OF THIN FILM SCINTILLATOR DETECTORS TO HIGH ENERGY ARGON AND KRYPTON IONS. Muga, L. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

The luminescence response of a thin film detector (TFD) to the passage of accelerated argon and krypton ions is recorded for an energy range (up to 7.2 MeV/nucleon) not previously studied. With increasing heavy ion energy the TFD response increases quickly to a maximum near 3 MeV/nucleon and then slowly decreases. The general trends observed are consistent with those calculated on the basis of a previously reported model of heavy ion luminescence production. Concurrent energy loss measurements of argon ions differ somewhat from calculated values. The expected diminished TFD response as specific-energy-loss increases is confirmed for the higher energy range of incident ions. Improved resolutions of thicker scintillator films indicate the possibility of establishing the identity of medium heavy ions (Z = 18 to Z = 36) to within two charge units using a film thickness of 0.4 mg/cm$^2$. Comments on the applicability of the TFD to various experimental areas are made. (auth)

**19699** (ORO-2843-24, pp vp, Sect. A) SPECIFIC LUMINESCENCE STUDIES OF ALPHA PARTICLES IN NE-102 SCINTILLATOR FILM. Bridges, J. D. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

A previous study of the specific luminescence ($\Delta L/\Delta x$) of Z = 1 and Z = 2 ions suggests that a decrease in $\Delta L/\Delta x$ occurs with decreasing ion energy just before the region of maximum energy loss is reached. Calculated specific luminescence ($dE/dx$) values of light and heavy ions support this indicated trend and experimental data using oxygen and heavier ions are consistent with this trend. In the case of oxygen ions, the decrease in $\Delta L/\Delta x$ was followed well below the energy region corresponding to maximum stopping power. However, because of relatively small $\Delta L/\Delta x$ values associated with Z = 1,2 ions, this downward trend has not heretofore been firmly established experimentally for these lighter ions. Using a $^{228}Th$ alpha decay source and thin film scintillator detectors (TFD) of suitable thickness, we have been able to follow the specific luminescence production by alpha particles into ion energy regions spanning the Bragg ionization maximum (i.e., maximum stopping power or energy-loss, $\Delta E/\Delta x$). Results are presented and discussed. (auth)

**19700** (ORO-2843-24, pp vp, Sect.B) OPTICAL PROPERTIES OF THIN FILM DETECTORS. Muga, L.; Burnsed, D. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

Since the invention of the thin film scintillator detector (TFD) numerous innovations in design have increased the efficiency of light collection, thereby resulting in improved operating characteristics. In order to better understand the nature of light transmission from the vicinity of the transiting ion path to the photomultiplier face, a series of experiments was performed in which various light guide and film support configurations were tested for efficiency. Masking of selective portions of the photomultiplier (PM) tube face revealed the extent to which emitted light was received at the exposed surfaces. By blocking off selected areas of the thin film surface from direct view of the PM tube faces, a measure of the light guiding efficiency of the thin film could be estimated. Results are presented and discussed. (auth)

**19701** (UCRL-51727) MEASUREMENTS OF THE ENERGY DEPENDENCE OF THE EFFICIENCY OF FISSION CHAMBERS. Carlson, G. W.; Larson, M. O.; Behrens, J. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Dec 1974. Contract W-7405-eng-48. 15p. Dep. NTIS $4.00.

Pulse height distributions from ionization fission chambers containing $^{233}U$, $^{234}U$, $^{235}U$, $^{236}U$, $^{238}U$, and mixtures of these isotopes were measured as functions of neutron energy over broad energy bands between 54 eV and higher than 30 MeV. These data were used to calculate fission chamber efficiencies as functions of energy range and pulse-height bias level. The energy variation of the efficiencies were found to be $\lesssim 1.3 \pm 0.7\%$ for efficiencies near 90%. From this result the energy variation in the efficiency was estimated to be less than 0.5% for the present chambers operated at their maximum efficiency. When bias levels are used that give efficiencies less than 80%, the efficiency decreases with increasing neutron energy. (auth)

**19702** USE OF THICK-LAYER NUCLEAR EMULSIONS TO DETECT TRANSITION RADIATION IN THE X-RAY RANGE. Zatsepin, V. I.; Razorenova, I. F.; Myl'tseva, V. A. Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 206-208(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1118-1120(1974).

Thick-layer nuclear emulsions can be used to detect transition radiation in the x-ray range through a count of the slow photoelectrons ($E \gtrsim 15$ keV) near the track of the producing particle. The method can be used to determine the energy of multiply charged particles in the range $\gamma = 10^3$ to $10^4$, since the yield of x-ray transition radiation varies as $z^2$. (auth)

**19703** DISCHARGE-DIFFUSION CHAMBER WITH A LARGE SENSITIVE REGION. Barnaveli, T. T.; Grigalashvili, N. S.; Dzhavrishvili, A. K.; Mandzhavidze, Z. Sh. Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 203-205(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1115-1117(1974).

A discharge-diffusion chamber which permits the attainment of a sensitive region 15 to 16 cm in size was designed. The track quality is good and the operation is stable. Photographs of charged particle tracks in the chamber are given. (auth)

**19704** ACOUSTIC DETECTION OF SINGLE PARTICLES. Volovik, V. D.; Kalinichenko, A. I.; Lazurik-El'tsufin, V. T. (Kharkov State Univ.). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 200-202(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1112-1114(1974).

The acoustic effects in a solid due to a very high-energy cascading $\gamma$ and due to a relativistic ion are evaluated with an account of the damping of the acoustic signal. The possible experimental detection of single $\gamma$ rays and of multiply charged ions on the basis of their acoustic effects in a solid is discussed in relation to the search for superheavy elements among the primary cosmic rays. (WHK)

**19705** PITFALLS IN GAMMA CAMERA FIELD UNIFORMITY CORRECTION. Hannan, W. J.; Bessent, R. G. (Western Regional Hospital Board, Glasgow). Brit. J. Radiol.; 47: No. 563, 820-821 (Nov 1974).

Sealed "flood" sources of $^{57}Co$ and $^{133}Ba$ are available commercially and are used to simulate the response of gamma cameras to the shorter half-life radionuclides $^{99m}Tc$ and $^{131}I$. However, serious errors can be made in attempting to carry out field uniformity corrections on some gamma cameras when a "flood" source is used which has a different gamma ray energy, or which produces a widely different count rate from the clinical study. A simple technique for obtaining a digital presentation of the uniformity of any gamma camera is described, and the results showed that the assumption of the independence of photon energy and count rate may be quite unjustified. Under these circumstances a $^{57}Co$ flood source cannot be used for uniformity correction of a $^{99m}Tc$ study; the radionuclide used in the flood source should be the same as that used in the clinical study, and the total count rate should be as close as possible to that obtained in the clinical investigation. (UK)

**19706** PROGRAMMING THE NUCLEAR DATA 50 : 50 SYSTEM. Wisbey, M. L.; Leach, K. G. (University Hospital of Wales, Cardiff, Eng.). Brit. J. Radiol.; 47: No. 563, 823-824 (Nov 1974).

This data analysis system is for use in the storage, display, and analysis of data from a gamma camera. The computer programs necessary to operate the system are supplied by Nuclear Data Inc., but in the standard 50 : 50 system the use of additional programs which employ sub-routines of the basic program to provide optional functions, is limited by the time taken in entering them; a full program takes 20 minutes to load via the punched paper tape-reader of the teleprinter. Two short additional programs were therefore written so that programs as well as scintigraphic data, may be stored within the computer, eliminating the use of paper tape and reducing this delay. (UK)

**19707** ANISOTROPIC ETCHING OF CHARGED-PARTICLE TRACKS IN CRYSTALS. Dorling, G. W.; Bull, R. K.; Durrani,

S. A.; Fremlin, J. H.; Khan, H. A. (Univ. of Birmingham, Eng.). Radiat. Eff.; 23: No. 2, 141-143(1974).

Terrestrial samples of mica (muscovite), olivine, feldspar (labradorite) and pyroxene (bronzite) have been irradiated with fission fragments from a $^{252}Cf$ source under conditions of 2 $\pi$ geometry. The samples of mica and pyroxene were etched in 48% HF at room temperature (21°C). Some samples of pyroxene were also etched in boiling 60% NaOH solution. This etchant was also used for the feldspars. The olivines were etched in WN etchant with pH's varying in the range 6 to 9. Tracks were measured and collected into angular groups of 10° width relative to a fixed, but arbitrary direction. At the same time the direction of any well-defined zones or cleavage planes was also recorded. All except mica showed some anisotropy of track distribution with angle. The results are presented and discussed. (auth)

**19708** CALIBRATION AND PRACTICAL USE OF A WHOLE-BODY COUNTER AS MEASURING DEVICE OF INTERNAL AND EXTERNAL CONTAMINATIONS. Giacco, G.; Scarpa, G. (Univ., Rome). G. Fis. Sanit. Prot. Radiaz.; 17: No. 2, 35-43(1973). (In Italian).

The results of a series of measurements carried out to calibrate the two-detector whole body counter of the Department of Medical Radiology, University of Rome are reported. The counter is mainly used for measuring internal and external contamination of the staff exposed to such risks. The evaluation of the calibration factors was performed by means of standardized radioactive solutions, using a multi-vessel phanton. The overall measuring errors of these calibration factors ranged between 1.5 and 3%. The results were applied to the quantitative check-up of the contamination level on the staff engaged in nuclear medicine activities within the Institute. By using Marinelli's chair geometry and setting the patient in a special body posture, it was possible to differentiate in-body activity (internal contamination) from activity deposited on the surface of hands (external contamination). This evaluation can be obtained with a 1000-seconds differential counting of the two detectors. In a series of contaminated patients measured activities were of the order of $10^{-8}$ Ci, mostly localized on the palms of the hands. (auth)

**19709** NUKLEARE ELEKTRONIK. (Nuclear Electronics). Abend, K.; Vogelsang, E. Munich; Thiemig (1973). 144p. (ISBN-3-521060-640).

The book shows how equipment for the processing of detector signals can be derived from electronic circuit elements. Its sections correspond to the signal flow of the arrangement of the nuclear radiation measuring techniques, e.g., radiation detectors (signal generation, ion pulse chamber, proportional counter tube, Geiger-Mueller counter tube, semiconductor detector, scintillation counter, Cherenkov counter, disturbance effects); amplifiers for radiation detectors (voltage and charge sensitive, logarithmic amplifier); pulse shaping circuits (RC circuits, delay line, zero line stabilizer, linear gate circuit, threshold circuit, pulse stretcher); converters for pulse amplitudes (threshold discriminator, analog-to-digital converters); time valuation circuits (coincidence and anti-coincidence circuit, time measuring circuits, constant ratio discriminator); digital circuits (counter and scaler, shifting register, adder, storer, multiplexer); particle counter arrangements; particle spectrometer, (spectroscopy system, multi-channel analyzers, time of flight measurement); position sensitive detectors (spark chamber, proportional counter tube with resistance wire, Charpak chamber, semiconductor detector; and on-line computers (CAMAC-system). This book by limiting itself to the essentials makes the modern state of technology for scientists and technicians both easy to understand and useful. (GE)

**19710** DETERMINATION OF THE TOTAL ($\alpha + \beta$) ACTIVITY OF LARGE AEROSOL FILTERS WITH A LIQUID SCINTILLATOR Buchtela, K.; Tschulovits, M. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Health Phys.; 27: No. 5, 491-496(Nov 1974). (In German).

A method for total ($\alpha + \beta$) assay of large air-filters (up to 320 $cm^2$) with the aid of liquid scintillation counting is described. The method includes a high figure of merit and gives a further application of liquid scintillation counting. (auth)

**19711** INSTRUMENT FOR THE STUDY OF SMALL ELECTRON FLUXES WITH ENERGIES OF $E_e \geq 40$ keV ON PROGNOZ SATELLITES. Zel'dovich, M. A.; Zubieva, T. G.; Kovalenskaya, M. A.; Logachev, Yu. I.; Lutsenko, V. N.; Pisarenko, N. F.; Savenko, I. A.; Shestopalov, I. P. Cosmic Res. (USSR) (Engl. Transl.); 12: No. 1, 128-131(1974).

Translated from Kosm. Issled.; 12: No. 1, 143-145(1974).

An instrument for the study of time variations in electron fluxes with energies of 40 keV $\leq E_e \leq$ 500 keV both during solar flares and in periods of low solar activity is described. Two gas-discharge end-window counters of type SBT-9 were used as the detectors. (WHK)

**19712** RECOMMENDED INSTRUMENTATION FOR URANIUM AND THORIUM EXPLORATION. Technical Reports Series, No. 158. Vienna; International Atomic Energy Agency (1974). 93p.

The performance specifications for uranium prospecting and evaluation instruments are given. The specifications are limited to the types of instruments which are useful in uranium and thorium exploration and which have been proven by experience in many areas of the world. The recommended instruments include portable Geiger-Müller counters; scintillation counters; gamma-ray spectrometers; airborne gamma-ray spectrometers and manometers or radon measurement instruments. The systems described are gross-count carborne and airborne survey systems; Geiger-Müller counter bore-hole logging systems and ore-grade control systems such as face scanners, T-handle probes, fixed-station truck loaded analyser systems etc. Each recommended instrument or system specification includes description as to its application, advantages and disadvantages, limitations, general description, sensitivity, operating life, etc. The specifications are intended to help in selection of adequate equipment to provide the geophysical-geological support needed to carry out programmes for radioactive mineral exploration and exploitation. (INIS)

**19713** POSSIBILITY OF USING A STREAMER CHAMBER TO STUDY DECAY PROCESSES. Zhankov, I. K.; Kuznetsov, V. M.; Stukov, O. I. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 50-51(1973). (In Russian).

The methods used and the results obtained in the registration of tracks of $\beta$ particles emitted by $^{60}Co$ with a streamer spark chamber are reported. The experiments were carried out for the purpose of determining the possible use of streamer chambers for the study of the decay processes of the nuclei of a target activated by an irradiation beam or for the decay of natural radioactive elements. The experiments showed that the isotropy of the chamber was sufficiently high and that decay tracks could be measured in almost a complete solid angle. (INIS)

**19714** SYNCHROTRON RADIATION DETECTION WITH THE USE OF THE UM-95 ELECTRON OPTICAL IMAGE CONVERTER. Medvedev, A. F.; Nikitin, M. M.; Ginzburg, M. I. pp 66-68 of Proceedings of the Scientific and Research Institute on Nuclear Physics, Electronics and Automatics of the Tomsk Polytechnical Institute. Charged Particle Accelerators. Moscow; Atomizdat (1973). (In Russian).

Some of the characteristics of the electron optical image converter UM-95 with a magnetic focusing system and a cooling system using liquid nitrogen vapor are described. A graph showed the distribution of the magnetic field along the axis of the focusing solenoids. The apparatus was designed for the experimental detection and investigation of synchrotron radiation. It can also be used for the study of the properties of ondulator radiation. (tr-INIS)

**19715** DATA PROCESSING SYSTEM AND RELIABILITY TESTS THE LOMNICKY STIT 4-NM-64 MONITOR DATA. Futo, A.; Dubinsky, J. (Slovenska Akademia Vied, Kosice (Czechoslovakia). Ustav Experimentalnej Fyziky). Acta Phys. Slovaca; 24: No. 2, 109-118(1974).

The data-collecting hardware of the 4-NM-64 neutron monitor at Lomnický stft together with the software system developed for the evaluation and reliability tests of the recorded data are described. It represents the optimum data processing system in which every measured value is tested several times before being included in or eliminated from the measured time series. The data processing system results are two sets of data available for the world cosmic ray laboratory network and for world data centers. (INIS)

**19716** NEUTRON FLUX DENSITY MEASUREMENTS WITH A FISSION IONISATION CHAMBER USING THE PULSE COUNTING AND CAMPBELL METHOD. Schmidt, K. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Kerntechnik; 16: No. 10, 437-441(Oct 1974). (In English, German).

It is shown that, using only one fission ionization chamber operated in a combined pulse counting and Campbell mode, it is possible to measure neutron flux densities from $10^0$ to $10^9$ $cm^{-2}$ $s^{-1}$, thus covering the entire range required for a power reactor. At neutron flux densities up to $2 \times 10^4$ $cm^{-2}$ $s^{-1}$ the gamma noise background may amount to up to $10^4$ R/h. At higher neutron flux densities a gamma background increase proportional to the neutron flux density increase can be tolerated up to a limit of $2.5 \times 10^6$ R/h. (auth)

**19717** REDUCTION OF ADDITIONAL GAIN VARIATIONS OF A STABILIZED SCINTILLATION DETECTION SYSTEM.

Sabol, J. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 127-132(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The block diagram is presented of a stabilizing unit for scintillation detectors. The use of the unit makes it possible to minimize the additional gain variations. Use is made of the properties of a buffer memory which, inserted at the input of the stabilizing circuit, makes the distribution of the processed reference pulses remarkably regular. (INIS)

**19718** FLUCTUATIONS IN MEASUREMENTS BY PROTECTIVE DEVICES WITH IONIZATION CHAMBERS. Nosenko, V. A.; Frolova, A. V.; Chernyaev, P. A. Med. Radiol.; 20: No. 2, 54-60(Feb 1975). (In Russian).

The results of testing protective devices of the MRM type when making measurements of low-level exposure doses of radiation are presented. It is shown, that the fluctuations noted in measurements developed mainly as a result of accidentally getting ionizing particles into the chamber. Fluctuations, measured on the apparatus of the MRM type were compared with calculated values. It is shown that with the increase in the time constant of the input circuit of the device, fluctuations decreased. Recommendations for making measurements of low-level capacities of photon radiation exposure doses with protective devices are given. (auth)

## Radiation Dosimeters

*Refer also to abstract 19830.*

**19719** (AECL-5018, pp 7-21) HEALTH PHYSICS BRANCH. Cowper, G. Nov 1974.

In Biology and Health Physics Division progress report, July 1 – September 30, 1974.

A quarterly report of research and development progress is presented. Topics include: thermoluminescence dosimetry, semiconductor detectors, environmental gamma radiation monitor, wide range pulse radiation detector, large area geiger counters (organic quenched), life testing of low sensitivity halogen quenched counters, tritium monitoring, effects of Ir impurities in Rh foil dosimeters, Monte Carlo calculations of neutron spectra, reproducibility of electrolytic conductance measurements in damage track neutron dosimeters, energy loss in thin films, analysis of argon-41 concentration data from meteorological records, argon-41 detection in air, analysis of sucrose gradient centrifugator data, uranium oxide level monitor, instruments in progress, and routine dose monitoring. (WHK)

**19720** (CEA-N-1766) LIMITS TO THE USE OF ACTIVABLE ELEMENTS CONNECTED TO AN INTEGRATING DETECTOR FOR THE DOSIMETRY OF INTERMEDIATE NEUTRONS. Spurny, F.; Portal, G. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Oct 1974. 16p. (In French). Dep. NTIS (US Sales Only) $4.00.

The limits to the use of activable elements connected to an integrating detector for intermediate neutron dosimetry were studied both theoretically and experimentally, taking as an example the case of thin thermoluminescent detectors enclosed between two gold foils. Experimental results were in good agreement with the theoretical approach and confirmed that the detection yield was about 40% of the intermediate neutron dose. On account of the high proportion of various other types of radiations in $\gamma$-neutron mixed fields, it was concluded that whatever the type of integrating and activable elements, such a device could be applied to very particular cases only. (auth)

**19721** (COO-1105-216) DEVELOPMENTS IN PASSIVE SOLID STATE RADIATION DOSIMETRY. Moran, P. R.; Cameron, J. R. (Wisconsin Univ., Madison (USA)). 1974. Contract AT(11-1)-1105. 8p. (CONF-740833-6). Dep. NTIS $4.00.

From 4th international conference on luminescence dosimetry; Krakow, Poland (27 Aug 1974).

A variety of projects in passive solid state radiation dosimetry have recently been active in the University of Wisconsin Medical Physics Laboratories. Of most important potential in a number of radiation dosimetry applications is the development of the "radiation induced thermally activated current" (RITAC effect) dosimetry system. Three years of research has led to the ultrahigh purity sapphire RITAC dosimeter which shows: (1) reliable measurement for doses below the millirad level, (2) linear response up to about 100 rad and useable range to $10^4$ rad, (3) long-term stability at room temperature, (4) extremely simple readout instrumentation, and (5) inexpensive and readily available dosimeter materials. Other projects have pursued techniques for fast neutron dosimetry by activation of TL phosphors, measurements of low-energy beta irradiation by induced TL glow-curve shape changes in LiF, and useful LiF sensitivation by pre-irradiations. Also, the transport dynamics of self-trapped holes in $CaF_2$ were studied by combining electron spin resonance and RITAC measurements, and some analytic and experimental checks of correlated TL and RITAC behavior outputs were completed. (auth)

**19722** DOSIMETRIC PROPERTIES OF THERMOPHOSPHORES LiF: (Ca + Mn). Druskina, L. S.; Shaver, I. Kh. (Ioffe Inst. of Physics and Tech., Leningrad). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 22-25(1974). (In Russian).

A thermophosphore was developed for dosimetry of ionizing radiation based on lithium fluoride doped with calcium from 0.5 to 3% and with manganese from 0.015 to 0.3%, the sensitivity of the luminophor being $5 \times 10^{10}$ quantum/g.rad. The thermal luminescence curve reveals one or two maxima, the position of which has been found to change from 200 to 300°C depending on the calcium and manganese concentration ratio. The dependence of the light sum on the gamma radiation dose is a linear function up to $5 \times 10^4$ r. The dosimetric information loss (fading) does not exceed 10% in 4 months. (auth)

**19723** COUNTER FOR THERMALLY STIMULATED EXOELECTRON STUDIES. Murthy, K. B. S.; Sunta, C. M.; Jain, V. K. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Pure Appl. Phys.; 12: No. 10, 685-688(Oct 1974).

A counter was designed and fabricated for the study of the phenomenon of thermally stimulated electron emission (TSEE); its design features are described and the TSEE data obtained with it are reported. Basically, it is a gas flow counter operated in the Geiger–Mueller region. The counter gas is argon flowing through ice-cooled isopropyl alcohol. The heater is a coil of 25 mm diameter which can be taken inside the sensitive volume of the counter. The heater is mounted on a platform which can be raised or lowered for varying its distance from the anode wire. The counting efficiency can thus be controlled. The working of the counter is satisfactory as regards the stability as well as reproducibility. (auth)

**19724** NEUTRON DOSIMETRY WITH A CALORIMETER. Bewley, D. K.; McCullough, E. C.; Page, B. C.; Sakata, S. (Hammersmith Hospital, London). Phys. Med. Biol.; 19: No. 6, 831-842(Nov 1974).

A calorimeter was used to measure the absorbed dose in tissue from a beam of fast neutrons. The calorimeter was of the twin type and was made of tissue-equivalent plastic. The calorimeter was calibrated electrically using the electrical resistivity of the plastic. The partial dose due to $\gamma$-radiation was measured separately with photographic film in order to derive the neutron dose alone. The results were compared with those found using ionization chambers. Satisfactory results were only obtained after pre-irradiation of the plastic by at least 100 krad of electrons. The accuracy obtainable by the calorimetric method seems similar to or slightly better than that obtainable with ionization chambers. (auth)

**19725** NEW CHEMICAL SYSTEMS FOR LOW-LEVEL FAST NEUTRON DOSIMETRY. Gupta, B. L.; Dvornik, I.; Zec, U. (Institut Rudjer Boskovic, Zagreb). Phys. Med. Biol.; 19: No. 6, 843-852(Nov 1974).

The response of two dosimetric systems to 14.7 MeV neutrons was studied. The systems were (1) 0.20 mmol ferrous sulphate, 5.0 mmol benzoic acid and 0.20 mmol xylenol orange in 0.05 N sulphuric acid and (2) 2,2,4-trimethylpentane + 10% (by volume) ethanol + 10% chlorobenzene + $1 \times 10^{-5}$ mol K-thymolsulphonphthalein up to 0.1% water + HCl. The average neutron flux in the irradiation cell was measured by filling the cell with magnesium acetate solution. The neutron flux incident on the surface of the cell was measured by aluminium activation. Efforts have been made to use the best available cross-section data and to achieve the highest possible experimental accuracy. The G-values and other details for the use of these systems in fast neutron dosimetry are given. (auth)

**19726** CURRENT INTEGRATOR FOR PROTON DOSIMETRY IN STUDIES ON RADIATION CHEMISTRY. Eremin, L. P.; Zaikin, V. F. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 57-58(1973). (In Russian).

The characteristics of a current integrator circuit for measuring proton currents are described. The circuit is based on the conversion of the measured charged particle current into a pulse sequence using a driven multivibrator. Currents can be measured in two ranges from $10^{-9}$ to $10^{-7}$ and from $10^{-8}$ to $10^{-6}$ amp while the frequency of the pulse sequence is varied from 20 to 2000 pulses/sec. (INIS)

**19727** DOSEMETER. Barta, C.; Neruda, J.; Suran, J.; Zemlicka, J. Czech Patent 149069. 23 Jul 1972. 3p. (In Czech).

A dosemeter is proposed made of activated thermoluminescent phosphate glass and containing an electric resistance material with terminals. Sintered zirconium dioxide or graphite can be used as the resistance material, e.g., in the form of a thin rod. Metallic materials with a suitable specific resistance in the form of wire, tape, net, etc., may also be used and may in addition be shaped into a spiral or meander. The resistance material may be fixed in the glass in various ways, e.g., by sealing. (INIS)

**19728** DOSIMETRY BY MEANS OF FILM-BADGE. Menin, A.; Tacconi, A.; Puppini, G.; Milanesi, R. (Instituti Ospitalieri, Verona, Italy). G. Fis. Sanit. Prot. Radiaz.; 17: No. 1, 1-6(1973). (In Italian).

On the basis of the fundamental concepts of film-badge personnel-dosimetry, the mathematical procedures used for the evaluation of the dose to the controlled individuals are described. It is demonstrated also that, by means of a suitable physico-mathematical treatment, all the procedures involved in the dosimetry operations can be automated. (auth)

**19729** CALIBRATION OF THE FINGER-RING TL-DOSIMETER. Bacelar Leao, J. L. (CBTN, Guanabara, Brazil); Oberhofer, M. (CBT). G. Fis. Sanit. Prot. Radiaz.; 17: No. 1, 24-29(1973). (In Italian).

Increasingly LiF thermoluminescence dosimeters are used for measuring finger doses. The calibration of a fingering dosimeter for x- and $\gamma$-radiation is described, which contains two extruded LiF rods, one of which is shielded by a high Z material. The ratio of both dosimeter readings yields the effective energy of the radiation. The quotient curve is given together with the correction factor curve of energy-dependence correction. (auth)

**19730** METHOD OF CHECKING PROVIDING INCREASE IN ACCURACY OF DOSIMETER DEVICES. Balon, Z. P.; Lyalina, L. I. (All-Union Scientific-Research Inst. of X-Ray and Radiology, Leningrad). Med. Radiol.; 20: No. 2, 48-50(Feb 1975). (In Russian).

The accuracy coefficient of the device as determined by checking the ratio of the model apparatus readings ($D_b$) to the readings of the tested instrument (N) should be considered as a product of coefficients: proportionality (Kp), range (Kd), hardness (Kk), detector (Kg), i.e., $K = D_b/N = Kp \cdot Kd \cdot Kk \cdot Kg$. The order of dosimeter checking must be strictly regulated. The determination of all the mentioned and improved coefficients will considerably increase the accuracy of dosimeters. The error of the dosimeter which is mentioned in the documentation supplied with it from the maximal value of the included range is unacceptable for such type of dosimeters and should be substituted for the error of the measuring value. (auth)

## *Nuclear Spectroscopic Instrumentation*

**19731** (BNWL-SA-5008) NaI(Tl)-Ge(Li) COINCIDENCE GAMMA-RAY SPECTROMETRY FOR RADIONUCLIDE ANALYSIS OF ENVIRONMENTAL SAMPLES. Brauer, F. P.; Kaye, J. H.; Fager, J. E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1 Nov 1974. Contract AT(45-1)-1830. 25p. (CONF-741213-7). Dep. NTIS $4.25.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

A multi-parameter NaI(Tl)-Ge(Li) coincidence gamma-ray spectrometry system has been developed for the analysis of nuclear power industry radioactive effluents in environmental samples. Several detector configurations have been evaluated. Data acquisition is by buffer storage of the ADC output and final recording of each event in list mode on magnetic tape. A 16K computer and a 4096 channel pulse height analyzer are used for accumulation of spectra from the data on magnetic tape. Display and software routines aid in the analysis of the spectral data. The system has been used to study environmental radiochemical analysis problems. (auth)

**19732** (CONF-741065-25) REGRESSION FILTER FOR SIGNAL RESOLUTION. Matthes, W. (Commission of the European Communities, Luxembourg). 1974. 25p. Dep. NTIS (US Sales Only) $4.00.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

The stepwise regression method and a computer simulation test of the method for resolving a measured pulse-height spectrum of a material mixture (e.g., gamma ray spectrum, Raman spectrum) into a weighted sum of the spectra of the individual constituents of the mixture are presented. (WHK)

**19733** (COO-3015-9) COMPUTER PROGRAM FOR ANALYSIS OF GAMMA SPECTRA. Subrahmanyam, V. (Boston Coll., Chestnut Hill, Mass. (USA). Dept. of Chemistry). Jul 1974. Contract AT(11-1)-3015. 36p. Dep. NTIS $5.00.

The SAMPO general-purpose semiconductor spectral analysis code is described. The code has been tested and revised over a period of years, and seems to provide a reliable and consistent procedure for analysis of a wide variety of Si(Li) and Ge(Li) semiconductor detector x-ray, $\gamma$-ray and under certain conditions, conversion electron spectra. The procedure employed by SAMPO is termed the "photopeak" method, because a prerequisite for analysis of spectral data is an exact mathematical representation of the photopeaks and the continua in their vicinity. The program itself is capable of determining the necessary peak shape parameters, provided the user can supply strong, "clean," singlet photopeaks in the region of interest so that the empirical peak shapes may be reduced to functional form. The general formalism presumed to describe semiconductor detector photopeaks consists of a central Gaussian with smoothly joined high- and low-energy exponential tails. The peak shapes are normally found to vary continuously as a function of energy; therefore, the exact shape parameters at each point in a spectrum can in principle be obtained by interpolation between points for which the standard peak shapes have been determined. (WHK)

**19734** (INT-59/E) PORTABLE SPECTROMETER FOR IN-FIELD MEASUREMENTS. Krasowski, R.; Hajduk, Z.; Turala, M. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). May 1974. 29p. (In Polish). Dep. NTIS (US Sales Only) $4.50.

A universal portable spectrometer having the capability of making radiometric measurements in the laboratory and under field conditions is presented. Construction and operation of separate circuit blocks are described. The digital part was designed on the basis of integrated circuits of the TTL low power family, while the linear part was designed for discrete devices. (auth)

**19735** (JINR-P6-8378) Ge(Li) IMPLANTED DETECTORS FOR $\beta$-PARTICLE SPECTROMETRY. Vylov, Ts.; Egoshin, I. N.; Lyatushinski, A.; Osipenko, B. P.; Yurkovski, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The technology of the Ge(Li) implanted detector, intended for $\beta$-particle measurements, is described. The energy resolution of 1.9 and 14 keV has been obtained for $E_\beta \sim 500$ keV and $E_\alpha \sim 5$ MeV, respectively. (auth)

**19736** (RFP-2328) OPERATING PARAMETERS AND LIMITATIONS OF A GERMANIUM-LITHIUM DRIFTED DETECTOR SYSTEM FOR THE IN VIVO MEASUREMENT OF AMERICIUM-241. Tyree, W. H.; Falk, R. B.; Liskey, R. W.; Wood, C. B. (Dow Chemical U. S. A., Golden, Colo. Rocky Flats Div.). 3 Feb 1975. Contract AT(29-1)-1106. 11p. Dep. NTIS $4.00.

The body counter facility at the Rocky Flats Plant provides for the detection of americium-241, as a tracer for plutonium, which is present in some plutonium mixtures. A germanium-lithium drifted system is described and application for the in vivo measurement of americium-241 is discussed. The operating parameters and limitations of the germanium-lithium drifted system for low-energy photon detection with particular attention to the entrance window response of one of the detectors are presented. Future development of germanium systems for the detection of low-energy photons in vivo will use hyper-pure germanium fabricated as thin-window planar detectors. (auth)

**19737** (RL-74-144) EFFICIENCIES OF LONG THERMAL NEUTRON DETECTORS. Meardon, B. H. (Science Research Council, Chilton (UK). Rutherford Lab.). Oct 1974. 38p. Dep. NTIS (US Sales Only) $7.25.

The use of long straight detectors is a common method of increasing detection efficiency in thermal neutron scattering experiments. The effects of the long detector approximation to the scattering cone are considered with special reference to a new diffuse scattering spectrometer at the Institut Laue-Langevin, Grenoble, France. (auth)

**19738** (UCRL-51709) ABSOLUTE SPECTRAL MEASUREMENTS OF ELECTRONS FROM HIGH-INTENSITY, NONREPETITIVELY PULSED SOURCES. Tirsell, K. G.; Multhauf, L. G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Dec 1974. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

The design and calibration of electron spectrometers applicable to spectral measurements of high-intensity, nonrepetitively pulsed sources are discussed. The main emphasis is on flat permanent-magnet spectrometers that enable one to measure several spec-

tral points simultaneously. Low-energy electron detectors suitable for use in these spectrometers are discussed as well as systems to record detector output current. Calibration procedures and results are presented for the silicon detectors found to be most effective. (auth)

**19739** (ZFK-271, pp 202-204) PROCESSING OF NEUTRON SPECTRAL DATA ON THE COMPUTER KRS 4200. Schoene, J. (Technische Univ., Dresden). Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The plans for processing neutron data from time-of-flight studies using the KRS-4200 computer are briefly outlined. (JSR)

**19740** CALIBRATION OF A NEUTRON TELESCOPE AND THE MEASUREMENT OF THE NEUTRON SPECTRUM FROM 70 TO 250 MeV IN THE UPPER ATMOSPHERE. Kanbach, G. Munich; Technische Univ. (1974). 94p. (In German).

Thesis.

The instrument makes use of the principle of the elastic neutron double collision for the simultaneous determination of energy and incidence angle. The device was calibrated in the range from 60 to 140 MeV with the aid of the neutron beam of the synchrocyclotron in Harwell, England, taking into account response capability and aspects of directional and energetic resolution. The obtained data were used for a calculation of the geometry factor of the apparatus for an evaluation of the experimental results obtained in two balloon flights. The evaluation confirms the theory of Haerendel (1964) concerning a generation of the highly energetic protons in the radiation belt according to a cosmic ray albedo neutron decay mechanism. (IAA)

**19741** HIGH COUNTING RATES FROM $^{125}$I IN RADIOIMMUNOASSAYS. Bell, T. K. (Royal Victoria Hospital, Belfast). J. Clin. Pathol.; 27: No. 11, 860-862(Nov 1974).

Responses from one manual and four automatic gamma counters for assaying $^{125}$I were compared. The resolution times quoted by manufacturers when applied in a standardized correction formula to obtain true counts from observed counting rates above $10^4$ counts per second appeared to be inadequate. The need to investigate the errors associated with high counting rates for all instruments and electronic settings employed to determine $^{125}$I in radioimmunoassays is emphasized. (auth)

## *High Energy Physics Instrumentation*

*Refer also to abstract 21013.*

**19742** (CRN/HE-74-15) STUDY OF THE DEVELOPMENT OF AN ELECTROMAGNETIC SHOWER AT HIGH ENERGY. Navarro-Savoy, A.; Steinmetz, I.; Croissiaux, M. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Centre de Recherches Nucleaires). Jul 1974. 40p. (In French). Dep. NTIS (US Sales Only) $5.00.

In order to calculate any type of homogeneous electron or photon detector, as lead glass detectors, or inhomogeneous as scintillator sandwichs or liquid argon detectors, programs were developed, to study the development of an electromagnetic shower initiated by a high energy (1 to 50 GeV) electron or photon. The general scheme of the program is first described. Then the calculations of the cross sections for the various processes are explained. The results which can be obtained from this program are finally discussed. (FR)

**19743** TRANSITION RADIATION FROM RELATIVISTIC ELECTRONS IN PERIODIC RADIATORS. Cherry, M.L.; Hartmann, G.; Müller, D.; Prince, T.A. (Enrico Fermi Institute and Department of Physics, University of Chicago, Chicago, Illinos 60637). Phys. Rev. D 10: No. 11, 3594-3607 (1 Dec 1974).

The generation and detection of transition radiation have been studied in a series of experiments with electrons from 1 to 15 GeV at SLAC and the Cornell Synchrotron. Periodic radiators, consisting of thin plastic foils stretched in air at constant spacings, were used, and proportional chambers filled with krypton and xenon served as detectors. A detailed discussion of the theoretical predictions is given, and the measurements are systematically compared with the predictions by varying the most critical parameters, such as configuration of radiators and detectors, and energy of the electrons. In general, good agreement between theory and experiment has been found. On the basis of these results, the criteria are summarized under which transition radiation can readily be observed. (auth)

**19744** DATA-RECORDING AND DATA-READOUT SYSTEM OF THE EAS APPARATUS COMPLEX. Silaev, A. A.; Solov'eva, V. I.; Nazarov, V. I.; Chukanov, V. A. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 197-199(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1109-1111(1974).

This system can record on perforated tape the data of the three basic units of the complex, i.e., the scintillation system and the underground and surface-level hodoscopes. The recording time is 2.5 sec. (auth)

**19745** MAGNETIC MUON SPECTROMETER 40 M WATER EQUIVALENT UNDER GROUND. Abrosimov, A. T.; Rozhdestvenskii, S. M.; Khrenov, B. A.; Khristiansen, G. B. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 192-196(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1104-1108(1974).

The incorporation of a magnetic muon spectrometer in the Moscow State University EAS apparatus will permit more systematic and accurate measurements of the muon energy and spatial distributions. Since there is an underground room at the center of the Moscow apparatus, the muon spectrometer could be installed at 40 m water equivalent under ground. This location completely eliminated the inteference in muon detection caused by the electron-photon and nuclear-active components of extensive air showers. Furthermore, there is a significant reduction of the background of low-energy muons (≤10 GeV) if the spectrometer is used to study single muons. The parameters of the magnetic muon spectrometer are reported, and data on the characteristics of extensive air showers in which it is possible to study muons with this spectrometer are given. (WHK)

**19746** MEASUREMENT OF THE EAS PARTICLE DENSITY WITH A THICK LIQUID SCINTILLATION DETECTOR. Dadykin, V. L.; Lidvanskii, A. S.; Solov'eva, V. I.; Stepanov, V. I.; Khristiansen, G. B.; Chudakov, A. E. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 189-191(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1101-1103(1974).

The "scintillation density" measured with a scintillation detector 23 g/cm$^2$ thick is compared with the particle density in extensive air showers determined from the indications of Geiger-Mueller counters at various distances from the shower axes. The accuracy with which the particle density in an extensive air shower can be determined by a thick scintillation detector is studied. (auth)

**19747** 200-m$^2$ COSMIC-RAY SCINTILLATION DETECTOR. Alekseev, E. N.; Alekseenko, V. A.; Voevodskii, A. V. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 185-188(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1097-1100(1974).

A large telescope counter composed of white-spirit liquid scintillation detectors for cosmic ray detection is described. The primary purposes of the apparatus are to observe variations in the cosmic-ray intensity and to study the central regions of extensive air showers. (WHK)

**19748** PRELIMINARY RESULTS OF A STUDY OF NUCLEAR INTERACTIONS OF MUONS AT ENERGIES UP TO $10^{12}$ eV. Berzrukov, L. B.; Enikeev, R. I.; Zatsepin, G. T.; Ryazhskaya, O. G. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 177-180(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1089-1092(1974).

A large liquid scintillation detector setup for distinguishing events of the nuclear type from events of the electromagnetic type on the basis of the neutrons in the shower that develops after the interaction of the muon is described. The apparatus is in a salt mine at a depth of 315 m water equivalent. Results are presented and discussed. (WHK)

**19749** EFFICIENCY CALCULATION FOR A DETECTOR OF THE EAS IONIZATION RADIATION AND PARAMETERS OF THE APPARATUS USED TO DETECT LOW-ENERGY EAS MUONS. Vernov, S. N.; Bezrodnykh, I. P.; Glushkov, A. V. (Inst. of Cosmic-Physics Research and Aeronomy, Novosibirsk, USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 161-165(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1070-1075(1974).

The parameters of an ionization radiation detector and its efficiency for detecting extensive air showers (EAS) with energies $E_0 \geq 10^{18}$ eV were calculated; the parameters of the apparatus were also calculated for studying EAS muons with energies $E_0 > 0.8$ GeV. (auth)

## Radiometric Instruments

*Refer also to abstract 19222.*

**19750** (INT-56/E) DEVICE FOR SELECTION OF INPUT PULSES OF THE BORE-HOLE NEUTRON GENERATOR. Dabek, T. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). 1974. 11p. (In Polish). Dep. NTIS (US Sales Only) $4.00.

A description of the device for selection of output pulses of the probe of a bore hole neutron generator is presented. The function of this device consists in the separation of the pulses transmitted by a common cable and subsequent composition of the pulse-pairs, i.e., master-pulse with pulse-train from the first detector, and the master-pulse with pulse-train from the second detector, respectively. (auth)

**19751** (INT-58/E) DIGITAL COUNTS-RATIO METER FOR TWO-DETECTOR RADIOMETRIC PROBES. Gaczol, R.; Palka, K. W. (Institute of Physics and Nuclear Techniques, Krakow (Poland)). 1974. 23p. (In Polish). Dep. NTIS (US Sales Only) $4.25.

A digital unit for computing the ratio of counting rates from two detector radiometric probes for density and moisture measurements in soils is described. The unit can also be used as scaler of signals obtained from different probes applied in well logging. (auth)

**19752** IMPROVEMENTS IN OR RELATING TO ELECTRON PROBE MICROANALYSERS. McFarlane, A. A. (to United Kingdom Atomic Energy Authority). British Patent 1,362,658/B/. 7 Aug 1974. 2p.

An electron probe micro-analyser consists essentially of an electron beam microscope having a specimen chamber associated with one or more x-ray spectrometers, including a proportional counter. Spectrometer crystals have been produced with a d-spacing of 50 Å, allowing use of the K-lines of F to B for probe analysis with standard spectrometers. Such crystals can be obtained by the deposition of monolayers of substances such as soap salts (for example, Ca, Ba, or Pb octadecanoates) on to a cylindrical substrate. An improved crystal is here described that comprises monolayers deposited on a substrate having the form of a portion of the surface of a torus or, preferably, a portion of the surface of a sphere. The use of such an arrangement allows the achievement of a greater concentration of diffracted radiation from the crystal and presents other advantages; amongst other things the intensity is increased at high Bragg angles, where it is most needed. A spherical arrangement is also easier to manufacture. Crystal substrates to the required spherical curvature may be constructed of opthalmic crown glass or formed by casting a low-shrinkage cold setting resin on to a spherical convex glass lens. The plastic substrate so formed has a lower specular reflection co-efficient for soft x-rays than glass and gives a lower background signal at lower Bragg angles. (UK)

**19753** EQUIPMENT FOR RADIOMETRIC DETERMINATION OF MOISTURE CONTENT OF SUBSTANCES, MAINLY CERAMIC RAW MATERIALS. Sojka, J.; Kominek, A. Czech. Patent 149897. 27 Oct 1972. 3p. (In Czech.).

A description is presented of an equipment consisting of a screw feeder provided with a measuring head attached to the output end. The arrangement is such where placed in the axis of the protective tube center are a source of fast neutrons, a detector of slow neutrons, and a detector of gamma radiation housed in a protective cover, and a detector of gamma radiation facing each other outside the measuring head. The equipment is also provided with an evaluation section having an adding or proportional circuit whose one input is connected to the output of the slow neutron detector via the first channel for the processing of the pulses corresponding to the detected neutrons and whose second input is connected to the output of the gamma radiation detector via the second channel for the processing of the pulses corresponding to the detected gamma radiation. (INIS)

**19754** METHODS OF MEASURING A PARAMETER STUDIED, SUCH AS SURFACE DENSITY, DENSITY, THICKNESS ETC. BY MEANS OF RADIOISOTOPES. Gregor, J. Czech Patent Application 150342. 20 Nov 1972. 5p. (In Czech).

A method is proposed suitable for the measurement of surface density, density, thickness, etc. using radioisotopes. The method is based on the simultaneous measurement of the studied variable by two or more sources of various types of radiation. It employs absorption and/or backscattering. (INIS)

**19755** EQUIPMENT FOR RADIOMETRIC DETERMINATION OF MOISTURE CONTENT OF SUBSTANCES, MAINLY CERAMIC RAW MATERIALS. Sojka, J.; Kominek, A. Czech Patent 149559. 29 Sep 1972. 3p. (In Czech).

The equipment is described consisting of a screw feeder provided with a measuring head attached to the output end of the feeder. The arrangement is such where placed in the axis of the protective tube, in a line one behind the other are a source of gamma radiation, a source of fast neutrons, a detector of slow neutrons and a detector of gamma radiation and an evaluation section with an amplifier whose input is connected to the output of the slow neutron and gamma radiation detectors and whose output is connected to the inputs of the adding or proportional circuit via the channel for the selection and processing of the pulses corresponding to the detected gamma radiation and via the channel for the selection and processing of the pulses corresponding to the detected neutrons. (INIS)

**19756** DEVICE FOR DETERMINING THE DENSITY OF SOLIDS. Simon, L. Czech Patent 149955. 23 Aug 1972. 4p. (In Czech).

A measuring device is described used in the determination of the density of building elements or of mineralization. It consists of a contact probe connected to a recording device. The contact probe consists of an emitter placed in a lead shielding case, a radiation detector and a pulse amplifier. The emitter and the detector are separated by a shielding partition. The detector is slidably adjustable along the longitudinal axis of the device. (INIS)

**19757** NEW FINDINGS IN THE RADIOMETRIC-ELECTRONIC MEASUREMENT OF LAYER THICKNESSES. Ott, A. (Fischer (H.) G.m.b.H. und Co., Sindelfingen (F. R. Germany)). Chem.-Ing.-Tech.; 46: No. 19, 805-811(Oct 1974). (In German).

A brief outline of the most important industrial methods in use at present for the measurement of layer thicknesses is followed by a discussion of the beta-backscattering method. The theoretical description of the dependence of backscatter coefficients on material parameters, layer thickness to be measured, and instrument constants is presented. It permits optimization of the measuring equipment for particular applications. Selected examples of characteristic applications in the measurement of layer thicknesses are outlined and the various combinations of materials that can be measured by this method are also mentioned. The uncertainty of a measurement is determined by means of a nomogram; the basic qualitative relationships are discussed. The measuring equipment available is briefly described. The article also deals with the measurement of alloy compositions, the measurement of multilayers by a double-beam method, and the radiometric measurement of the density of solids by the backscatter method. (auth)

**19758** REMARKS ON MEASUREMENT BY GAMMA BACKSCATTERING. Musilek, L. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 133-140(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The results are listed of a series of measurements aimed at optimizing the configuration for the thickness measurement by gamma backscattering. Coaxial configuration with the source in the axis of the detector in the proximity of the measured material is considered. Several effects, characteristic of the given method are investigated that may influence the error of measurement such as the effect of the inclination of the measuring probe to the plane of the material, the effect of the measured area curvature, and the interfering effect of a second material behind the measured wall. (auth)

## Radiation Effects on Instrument Components, Instruments, or Electronic Systems

*Refer also to abstracts 20168, 20468, 20469, 20486, and 20493.*

**19759** (AD-777896) SIMPLIFIED MICROCIRCUIT MODELING. Final Report, 31 May 1972–14 Nov 1973. Pocock, D. N.; Krebs, M. G.; Perkins, C. W. (Northrop Research and Technology Center, Hawthorne, Calif. (USA)). Mar 1974. Contract F29601-72-C-0092. 274p. (NRTC-73-43R). NTIS $6.50.

Results are presented on the application of previously developed techniques to generate radiation-inclusive simplified models of several types of digital and linear microcircuits of medium-scale integrated/large-scale integrated (MSI/LSI) complexity. Methods for including the effects of neutron degradation and electrical pulse overstress in simplified terminal models are developed. Models were generated for a transistor-transistor logic (TTL) decade counter, complementary/metal oxide semiconductor (C/MOS) full adder, voltage comparator, video/buffer amplifier, low-level/voltage clamp amplifier, and a bootstrap amplifier. The models represent the electrical and radiation responses of the devices within engineering accuracy and are applicable to the computer-aided design and analysis of large electronic systems. It has been concluded that simplified microcircuit modeling is a viable and important technology that allows systems analysis on existing computer codes. Further development of generalized techniques is recommended. (auth)

**19760** (AD-782015) EFFECTS OF NUCLEAR RADIATION ON MAGNETIC BUBBLE DOMAIN MATERIALS AND DEVICES. Williams, R. A. (Rockwell International Corp., Anaheim, Calif. (USA). Electronics Research Div.). Oct 1973. Contract F19628-73-C-0250. 45p. (AFCRL-TR-73-0712). NTIS $3.25.

The work described in this report is an extension of work performed on Contract No. F19628-72-C-0342. The present effort is primarily concerned with establishing failure thresholds and mechanisms of magnetic bubble domain devices. Four types of experiments were performed. A study was made of the effect of 60 kV x-rays on the hard bubble suppression properties of a neon implanted layer in (YSM) 3 (FEGA) 5012 material. Radiation burnout of 300 A permalloy domain sensors was found to occur with 30 ns pulses of 1.5 MeV electrons at doses above 30,000 rads/pulse. The stability of stored information in a transient ionizing environment was investigated. Finally, measurements were made of the transient radiation response of domain sensors. (auth)

**19761** (AD-783988) INVESTIGATION OF CHROMIUM-DOPED OXIDES. Final Report, 1 November 1971–1 November 1973. Kjar, R. A. (Rockwell International Corp., Anaheim, Calif. (USA). Electronics Research Div.; Office of Naval Research, Washington, D. C. (USA)). Nov 1973. Contract N00014-72-C-0017. 155p. (C71-1063/501). NTIS $5.00.

Part I of the report describes results obtained during the investigation of the mechanisms by which chromium-doping of a silicon-dioxide gate insulator may improve the radiation resistance of MOS devices. Part II details the fabrication and testing of a CMOS/SOS 4-bit adder that employed chrome-doped and aluminum ion-implanted gate oxides to provide improved radiation hardness. (GRA)

**19762** (AGC-2691) STRAIN GAGE RESEARCH AND HIGH OUTPUT TRANSDUCERS. (Aerojet-General Corp., Azusa, Calif. (USA)). Sep 1963. 89p. Dep. NTIS $7.50.

Tests were performed in and out of radiation environments on strain and temperature transducers of the surface mounted sprayed ceramic bond type (Rokide). The results of these tests are evaluated. A tentative process specification was written to describe the method of attaching sprayed ceramic bonded surface transducers and a cooperative development program has been conducted with the Baldwin-Lima-Hamilton Corporation to develop suitable packaging methods specifically for such transducers. An exploratory nonirradiation test was performed to investigate the feasibility of generating a ±1 volt continuous output from a bonded strain gage experiencing a microstrain stimulus of 3000. Sprayed ceramic bonded strain gages were installed on a representative group of ATJ graphite samples and these samples were tested to destruction in compression. The results of these tests are evaluated. (auth)

**19763** (AGC-2691(Rev.)) STRAIN GAGE RESEARCH AND HIGH OUTPUT TRANSDUCERS. (Aerojet-General Corp., Azusa, Calif. (USA)). Jan 1964. 89p. Dep. NTIS $7.50.

The research and development program was initiated in strain gage technology for two purposes: (1) to develop a radiation resistant strain gage for measuring surface strains; and (2) to improve the state-of-the-art of bonded strain gage pressure transducers and accelerometers so that they can be used in radiation environments. In the course of this development, the method of mounting strain gages using an aluminum oxide spray method (Rokide) was developed. A preliminary radiation test conducted in GTR in October, 1962 on four strain gages and three resistance thermometers mounted by this Rokide method showed great promise. A detailed process specification describing this mounting process using specially designed strain gages was written. A second radiation test was conducted in May, 1963 in GTR at 700°F using two test fixtures. In these test fixtures, 72 Rokided gages were tested, representing 11 different types. The test results are summarized in chart form. (WHK)

**19764** (AGC-8771-2219) PRE-IRRADIATION ANALYSIS, ROSEMOUNT PRESSURE TRANSDUCER MODEL 810C. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Nov 1963. 10p. Dep. NTIS $4.00.

Rosemount pressure transducer (Model 810C) was analyzed for its compatibility with and possible behavior in a radiation environment. Its threshold damage is based on the behavior of silicon, and is set at $10^{13}$ n/cm$^2$ and $10^8$ ergs/g(C). Gamma heating rates in two flux levels are considered. Induced activities were computed and the total at the end of a 100 hr-GTR test is 0.09 curies. (auth)

**19765** (AGC-8771-2256) WINSCO PLATINUM RESISTANCE TEMPERATURE TRANSDUCER MODEL 2610-2. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1963. 10p. Dep. NTIS $4.00.

Winsco Resistance Temperature Transducer 2610-2 is radiation resistant and should be able to withstand radiation dosages in excess of those prescribed for NERVA ($10^{11}$ ergs/gm(C)-hr and $10^{14}$ nv fast neutrons). The accumulative neutron damage and gamma heating in the NERVA flux rate will cause errors in temperature readout which may not be tolerable. The error induced by gamma heating may be reduced by re-design of the mandrel on which the resistance wire is wound. (auth)

**19766** (AGC-8771-2365) EVALUATION OF ROSEMOUNT ENGINEERING COMPANY MODEL 134EB RADIATION RESISTANT CRYOGENIC TEMPERATURE SENSOR, SERIAL NO. 2826. Nolte, E. R.; Chandon, H. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). 8 Jan 1963. 24p. Dep. NTIS $4.25.

Rosemount Engineering Company designed and fabricated a resistance temperature transmitter (RTT) for evaluation by Aerojet-General Corporation. It was requested that this unit be radiation hardened to be suitable for the NERVA environments, electrically equivalent to the Model 134CT, and mechanically interchangeable with the Model 134CT. The Model 134CT, also manufactured by Rosemount, is qualified for Test Area service. In September 1962 an evaluation Model 134EB, S/N 2826, was provided. This laboratory report documents the extensive test program to which this RTT was subjected. (auth)

**19767** (AGC-8771-2375) SERVONIC PRESSURE TRANSDUCER MODEL 2121-01. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 21 Jan 1964. 8p. Dep. NTIS $4.00.

Servonic Pressure Transducer, Model 2121-01, was determined to be a radiation-resistant instrument. When used in the NRX-A2 environment the transducer requires shock mounting which thermally isolates the instrument from a heat sink. Without provision for cooling, the assembly is limited to fields of $1.2 \times 10^9$ ergs/gram(C)-hr for full-duration, full-power runs. This is based on the exclusion of soft solder and on the premise that no component should exceed the upper temperature compensated limit (500°F). The transducers have proved reliable in ground test reactor irradiation tests at flux levels of $3.6 \times 10^9$ ergs/gram (C)-hr with cooling provided. (auth)

**19768** (AGC-8771-2570) CONSOLIDATED CONTROLS CORPORATION LVDT PRESSURE TRANSDUCERS MODELS 413M35 AND 412M102. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 10 Mar 1964. 24p. Dep. NTIS $4.25.

Consolidated Controls Corporation LVDT Pressure Transducers, Models 413M35 and 412M102, were analyzed to determine their expected performance in a radiation field. It was estimated that they can withstand integrated fluxes of $5 \times 10^{17}$ n/cm$^2$ or $1.1 \times 10^{11}$ ergs/gram(C). The signal conditioning units are limited to $10^{13}$ n/cm$^2$ and $10^9$ ergs/gram(C). The maximum flux levels they may be subjected to depend upon the length of the exposure and the means devised to dissipate heat. The maximum field for a full duration NRX-A2 run without provision for cooling is $3.6 \times 10^9$ ergs/gram(C)-hr (.1 watt/gram(C)), based on the adiabatic heating rate of silver. A cooling jacket has been devised for cooling the transducers so they can be located in fields of $3 \times 10^{10}$ ergs/gram(C)-hr (.84 watts/gram(C)). Since the design is based on steady state conditions, the time of operation at this level is determined by integrated dosage limitations. (auth)

**19769** (BNL-19488) FAST NEUTRON RADIATION DAMAGE OF HIGH-PURITY GERMANIUM DETECTORS. Kraner, H. W.; Pehl, R. H.; Haller, E. E. (Brookhaven National Lab., Upton,

N. Y. (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. 22p. (CONF-741213-10). Dep. NTIS $4.25.
From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

Seven high resolution, high-purity planar germanium and two lithium-drifted germanium detectors have been exposed to fluences of monoenergetic fast neutrons of 1.4, 5.5 and 16.4 MeV to study radiation damage effects. Seven of the exposures were made at 5.5 MeV using detectors made from both LBL and General Electric Company material. Initial degradation of $^{60}Co$ energy resolution was generally observed after fluences of $3 \times 10^{+9}$ n/cm$^2$. After fluences of $10^{10}$ n/cm$^2$, the detector resolutions were all affected, and replacement would be required in most gamma ray spectrometry; these results are consistent with previous damage studies on germanium detectors. Considerable variability in neutron damage threshold between detectors was observed within this fluence range which must be attributable to a material parameter that is not yet fully determined. This is the major finding in this study. (auth)

**19770** (RN-DR-0044) DEVELOPMENT OF NERVA COPPER–CONSTANTAN IMMERSION THERMOCOUPLES. Chandon, H. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1964. 95p. Dep. NTIS $7.75.

The objective of this program was to develop copper-constantan thermocouples for the NRX-A2 instrumentation kit which were capable of: (1) operating within the NRX-A2 environment, (2) measuring temperatures in the −425 to +700°F range, (3) converting the output millivolt signal to temperature by one master electromotive force versus temperature table, and (4) having an accuracy of ±2% over the −425 to −300°F range; ±1% over the −300 to −100°F range; ±1°F over the −100 to +200°F range; and ±0.5% over the +200 to +700°F range. All significant analyses and testing performed during the development of the copper-constantan thermocouples and the test results are described. (WHK)

**19771** (RN-S-0121) PRELIMINARY TEST REPORTS FOR GROUND TEST REACTOR (GTR) TEST NO. 12A. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1964. 39p. Dep. NTIS $5.00.

Preliminary test reports covering strain gages (23/A406), resistance temperature transducers (23/L101) and cables (23/A601) which were irradiated during test number 12A at the Ground Test Reactor, Fort Worth, Texas are presented. (auth)

**19772** (RN-S-0325) FINAL DATA REPORT: LVDT PRESSURE TRANSDUCER EXPERIMENT No. 23/R510. Oggerino, J. P. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1967. 57p. Dep. NTIS $6.00.

Four Consolidated Controls Corporation pressure transducers (Model No. 412M117-250) were irradiated in the Plum Brook Reactor Facility at Sandusky, Ohio. The integrated fast neutron flux (fluence) was $3.0 \times 10^{16}$ (n/cm$^2$) ($E_n > 1.0$ Mw). The integrated gamma dose was $8.5 \times 10^8$ Rads (C). Transducer signal failure occurred at a heat deposition rate of 0.75 watts/gm (15 Mw), but pretest moisture damage of cable/connector assemblies was instrumental in the failure. Posttest operations indicated that the transducers physically withstood radiation exposure satisfactorily. (auth)

**19773** (RN-S-0370) FAST AND THERMAL NEUTRON AND PROTON EFFECTS ON PLATINUM RESISTANCE TRANSDUCERS AT LIQUID HYDROGEN TEMPERATURE. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1967. 133p. Dep. NTIS $9.75.

Twenty platinum resistance temperature transducers (RTT) were irradiated in the 200-hour GTR-18 test to assess radiation damage at liquid hydrogen temperatures. The test included 11 units that were used to determine the mechanism of damage to the probes, three development transducers for evaluation, and six units that had been irradiated in previous GTR tests to determine effects of extended exposures and to observe evidence of radiation hardening. The units used in the mechanism of damage study were Rosemount 134EB186 transducers, and a current of 4.5 milliamps was used for each unit. Shielding was provided for protons, thermal neutrons, and epithermal neutrons. The test conditions and the results are presented. (WHK)

**19774** (RN-TM-0170) FEASIBILITY REPORT FOR A HIGH OUTPUT STRAIN GAGE ACCELEROMETER. Sita, E. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). 25 Feb 1965. 24p. Dep. NTIS $4.25.

One of the necessary requirements during the developmental phase of the NERVA engine is the measurement of vibration levels and vibration frequencies under operating conditions. The anticipated acceleration ranges are 25 and 50 g with a frequency range of 0 to 1000 cps. Accelerometers used for these measurements, in addition to satisfying the acceleration and frequency range requirements, must be radiation hardened, have a high output for a good signal-to-noise ratio, and be compatible with the high gamma heating rates of the NERVA engine. A study to determine the feasibility of using a Rokide bonded strain gage for this purpose is presented. (WHK)

**19775** (TID/SNA-793) REQUIREMENTS FOR TESTS OF EFFECTS OF GAMMA RADIATION ON ELECTRONICS. Test 28A001A (Rev 0) PMOS Power Switch (Ambient). Test 28A002A (Rev 0) PMOS Power Switch ($LN_2$). (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1971. 49p. Dep. NTIS $5.50.

The purpose of this test was to establish the feasibility and circuit complexity bounds for cryogenic, radiation hardened, p-channel, enhancement-mode, metal-oxide-semiconductor (PMOS) power switching devices in meeting NERVA valve actuator electronics requirements. This was a series of tests that was necessary to completely characterize the operation of PMOS power switches in the NERVA reactor radiation field. (WHK)

**19776** (TID/SNA-801) REQUIREMENTS FOR TESTS OF EFFECTS OF GAMMA RADIATION ON ELECTRONICS: 28A003A (REV 0) PMOS POWER SWITCH (AMBIENT-DYNAMIC); 28A004A (REV 0) PMOS POWER SWITCH ($LN_2$-DYNAMIC); TEST 28A003B (REV 0) PMOS NOR GATE (AMBIENT-DYNAMIC); TEST 28A004B (REV 0) PMOS NOR GATE ($LN_2$-DYNAMIC). (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Jan 1972. 72p. Dep. NTIS $6.75.

The purpose of this test was to establish the feasibility and circuit complexity bounds for cryogenic, radiation hardened, p-channel, enhancement-mode, metal-oxide-semiconductor (PMOS) power switching devices in meeting NERVA valve actuator electronics requirements. This was a series of tests that was necessary to completely characterize the operation of PMOS power switches in the NERVA reactor radiation field. (WHK)

**19777** (WANL-TME-420) FINAL TEST SPECIFICATIONS FOR CANDIDATE NRX-A DIAGNOSTIC TRANSDUCERS TO BE IRRADIATED AT THE GROUND TEST REACTOR DURING JULY 29–AUGUST 2, 1963. Kalapaca, H. P. (comp.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Jul 1963. 62p. Dep. NTIS $6.25.

During the time period July 29 to August 2, 1963, the third combined environment test on candidate NRX-A diagnostic transducers will be conducted at the Ground Test Reactor located at the General Dynamics/Fort Worth Facility in Fort Worth, Texas. The items to be tested are identified as follows: accelerometers, pressure transducers, linear displacement transducers, thermocouples and thermocouple connectors, strain gages, and resistance thermometers. Test procedures are specified. (auth)

**19778** (WANL-TME-420(SUPPL.1)) FINAL TEST SPECIFICATIONS FOR NRX-A DIAGNOSTIC TRANSDUCERS TO BE IRRADIATED AT THE GROUND TEST REACTOR DURING JULY 29–AUGUST 2, 1963. Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1963. 7p. Dep. NTIS $4.00.

WANL-TME-420 was issued with some specific information concerning diagnostic transducer irradiations at the Ground Test Reactor to be completed at a later date by the Radiation Effects Program Department. This supplement to WANL-TME-420 supplies that information, plus revised flux data, to the following sections: Section V: TEST ENVIRONMENT; and Section VI: ANALYTICAL. The items for which the information is supplied are accelerometers, pressure transducers, linear displacement transducers, thermocouples and thermocouple connectors, strain gauges, and resistance thermometers. (auth)

**19779** (WANL-TME-421(Suppl.1)) SUPPLEMENT TO TEST SPECIFICATIONS FOR NRX-A CANDIDATE DIAGNOSTIC TRANSDUCERS TO BE IRRADIATED AT THE PLUM BROOK REACTOR DURING JULY 22-24, 1963. Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jul 1963. 6p. Dep. NTIS $4.00.

WANL-TME-421 was issued with some specific information concerning transducer irradiations at the Plum Brook reactor to be completed at a later date by the Radiation Effects Program Department. This supplement to WANL-TME-421 supplies that information which was missing. The three items being irradiated in these tests are strain gages, resistance thermometers and copper-constantan thermocouples. Since these three test items are to be contained in a single sample fixture and will be irradiated simultaneously, the information to be supplied to the test specifications for each test item will be identical. Thus, the information contained herein is applicable to each of the four sections and is presented without reference to the test item. (auth)

**19780** (WANL-TME-433) PRELIMINARY TEST SPECIFICATIONS FOR NRX-A CANDIDATE DIAGNOSTIC TRANSDUCERS TO BE IRRADIATED AT THE GROUND TEST REACTOR DURING SEPTEMBER 1963. Kalapaca, H. P. (comp.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Jul 1963. 51p. Dep. NTIS $5.75.

In September 1963, the fourth combined environment test on candidate NRX-A diagnostic transducers will be conducted at the Ground Test Reactor located at the General Dynamics/Fort Worth Facility in Fort Worth, Texas. The items to be tested are as follows: accelerometers, pressure transducers, linear displacement transducers, strain gages, and resistance thermometers. Specifications for the test equipment and procedures are given. (WHK)

**19781** (WANL-TME-439) TEST SPECIFICATIONS FOR NRX-A CANDIDATE LINEAR MOTION DISPLACEMENT TRANSDUCERS TO BE IRRADIATED AT THE PLUM BROOK REACTOR DURING AUGUST, 1963. Kalapaca, H. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Jul 1963. 15p. Dep. NTIS $4.00.

The purpose of this experiment was to obtain operation data on NRX-A candidate linear motion displacement transducers in a high dose rate radiation environment. Test equipment and procedures are given. (WHK)

**19782** (WANL-TME-581(Rev.)) FINAL TEST SPECIFICATIONS FOR NRX-A CANDIDATE PRESSURE TRANSDUCERS TO BE IRRADIATED AT THE PLUM BROOK REACTOR (23/W505). Simoncini, M. V.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1964. 21p. Dep. NTIS $4.25.

Specifications are given for the equipment and procedures to obtain operational data on NRX-A candidate pressure transducers in a high dose rate radiation environment. (WHK)

**19783** (WANL-TME-617(Rev.)) TEST SPECIFICATIONS FOR NRX-A CANDIDATE ACCELEROMETER DISCS TO BE IRRADIATED AT THE PLUM BROOK REACTOR (23/W003). Loftus, W. D.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Jan 1964. 13p. Dep. NTIS $4.00.

The purpose of this experiment was to determine the effects of a high dose rate radiation environment on the electrical characteristics of several types of piezoelectric ceramic discs such as utilized in piezoelectric accelerometers. The discs will be mounted in a test fixture which will be inserted into the Plum Brook test capsule. Significant electrical parameters will be measured and recorded before and after irradiation only. (auth)

**19784** (WANL-TME-620) FINAL TEST SPECIFICATIONS FOR NRX-A CANDIDATE ACCELEROMETERS AND PRESSURE TRANSDUCERS TO BE IRRADIATED AT GTR REACTOR (23/W007 and 23/W507). Polak, C. G.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 5 Dec 1963. 29p. Dep. NTIS $4.50.

The purpose of this experiment was to obtain operational data on NERVA candidate accelerometers under combined cryogenic and elevated temperatures, vibration and radiation environment. Two accelerometers are mounted on each of four vibration generators. The accelerometers are used both to monitor the vibrations and as accelerometer test candidates. The facility requirements and procedures are given. (WHK)

**19785** (WANL-TME-620(Rev.)) FINAL TEST SPECIFICATIONS FOR NRX-A CANDIDATE ACCELEROMETERS AND PRESSURE TRANSDUCERS TO BE IRRADIATED AT GTR REACTOR (23/W007 and 23/W507). Polak, C. G.; Loftus, W. D.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Jan 1964. 31p. Dep. NTIS $4.75.

The purpose of this experiment was to obtain operational data on NERVA candidate accelerometers under combined cryogenic and elevated temperatures, vibration and radiation environment. Two accelerometers are mounted on each of three vibration generators. Frequency response measurements on the accelerometers will be made at intervals during the test. (auth)

**19786** (WANL-TME-702) PRELIMINARY TEST SPECIFICATION FOR NRX-A CANDIDATE LINEAR MOTION DISPLACEMENT TRANSDUCERS TO BE IRRADIATED AT PLUM BROOK REACTOR (23/W205). Pappas, T. A.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1964. 13p. Dep. NTIS $4.00.

The purpose of this experiment was to obtain operation data on NRX-A candidate linear motion displacement transducers in a high dose rate radiation environment. Test equipment and procedures are given. (WHK)

**19787** (WANL-TME-708) PRELIMINARY TEST SPECIFICATIONS FOR NRX-A CANDIDATE RESISTANCE TEMPERATURE TRANSDUCERS TO BE IRRADIATED AT THE PLUM BROOK REACTOR (23/W106). Murray, T. P.; Solberg, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1964. 16p. Dep. NTIS $4.00.

The purpose of this experiment was to obtain operational data on NRX-A candidate resistance temperature transducers under a high dose rate radiation environment. The transducers will be mounted on a test fixture which will be inserted into the Plum-brook test capsule. D.C. electrical excitation will be supplied to the resistance elements. The outputs will be read and recorded, and the readings compared with those of comparison thermocouples. (auth)

**19788** (WANL-TME-1058) HEAT TRANSFER CALCULATIONS AND DESIGN CRITERIA FOR ELECTRICAL TRANSDUCERS OPERATING IN A NUCLEAR ENVIRONMENT. Blinn, H. O. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1964. 62p. Dep. NTIS $6.25.

The heat transfer characteristics of several types of NERVA candidate electrical transducers were studied. Analysis of heat transfer aspects prior to irradiation is helpful in predicting the internal temperature during irradiation and thus, aids in selecting suitable types for testing. In general, the purpose of the heat transfer analysis is to guarantee a completely safe test, predict operational parameters, prevent effort on instruments which will obviously fail during testing and also help an instrument designer select arrangements for new designs that will give satisfactory heat transfer performance and thereby satisfy NERVA requirements. Various materials of construction are discussed with respect to their thermal operating characteristics in a radiation environment. A method for calculating the internal temperatures of an instrument operating in a nuclear environment is presented. (auth)

**19789** (WANL-TME-1066) STRAIN GAGE TEST, EXPERIMENT NO. 23/W406 IRRADIATED AT THE PLUM BROOK REACTOR FACILITY PBRF CYCLE 20P (PB No. 7W). Coombe, J. R.; Kalning, L.; Pappas, T. A.; Rothleder, B. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1964. 26p. Dep. NTIS $4.50.

Strain gages are to be utilized in the NERVA reactor to diagnose strain in structural members. The primary purpose for irradiation experiments of various candidate strain gages is to study both their operational behavior and the manner of attachment to the reactor component in a high-radiation environment. This report presents test information and test evaluation of thirteen (13) Microdot weldable strain gages irradiated at the Plum Brook Reactor on July 2–4, 1964 during PBRF Cycle 20P. (auth)

**19790** CURRENT TRANSFER THROUGH ONE- AND TWO-LAYER DIELECTRIC IN IRRADIATED MIS-STRUCTURES. Girii, V. A.; Kondrachuk, A. V.; Kornyushin, S. I.; Shakhovtsov, V. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 9, 1537-1542(Sep 1974). (In Russian).

The current–voltage and current–temperature characteristics of MIS-structures under different electric fields in the dielectric ($10^4$ to $10^5$ V·cm$^{-1}$) at 77 to 470°K were studied before and after irradiation. It is shown that both I(V, T) characteristics and the influence of the irradiation on them are different for one- and two-layer dielectrics. The mechanisms of the current transfer are considered in terms of accepted models. There are some discrepancies between the present data and known mechanisms of current transfer in such structures. Possible reasons for these discrepancies are analyzed. The effects of $\gamma$-irradiation on the I(V) and I(T) characteristics are discussed on the basis of information on the nature of different components responsible for the current formation. (auth)

**19791** EFFECTS OF IONIZING RADIATION ON MDP STRUCTURES. Lisovskii, I. P.; Litvinov, R. O. (Inst. of Semiconductors, Kiev). Poluprov. Tekh. Mikroelektron.; No. 18, 67-80 (1974). (In Russian).

Factors affecting the charge in the oxide and fast surface states induced by radiation (radiation dose and grid bias during irradiation) are studied using the Si-$SiO_2$-metal system as an example. Probable models of radiation effects, explaining the dependence of the behavior of MOP devices on the irradiation conditions, are examined. Characteristics of the thermal and uv annealing of radiation defects are indicated. (7 figures, 3 tables, 53 references) (tr-auth)

## Miscellaneous Instruments

*Refer also to abstracts 20191, 21414, and 21441.*

**19792** (AGC-8771-2551) EVALUATION TESTING OF STATHAM PRESSURE TRANSDUCERS MODEL NO'S. (PA732TC, PL732TC, AND PG732TC. Felter, M. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 2 Mar 1964. 44p. Dep. NTIS $5.25.

Evaluation tests for functional acceptance, dynamic response, vibration, shock, humidity, temperature, and irradiation effects were performed on Statham transducer Models PA732TC (PA = absolute), PG732TC (PG = gage), and PL732TC (PL = differential). Five units that failed one or more of these tests were opened and inspected to determine the cause of failure. Broken strain wires caused most of the failures. Humidity testing revealed untreated metal surfaces near the strain wires and rust or corrosion was found on the over-travel post and springs. One transducer, S/N 418, became inoperative during normal shipping and handling. When the transducers were disassembled the following manufacturing discrepancies were revealed: soft solder was used for junctions, "spitball" resistors were used for zero adjustment, and threaded fasteners (7 screws) were used in the assembly. Many transducers failed acceptance testing because of zero shift, low insulation values, or shorts. Results of the evaluation tests are not conclusive because at least three design changes, with no corresponding change in model number, were made during the evaluation period. This was not discovered until the transducers were opened for examination to determine the cause of failure. (auth)

**19793** (AGC-90063) COMPONENT DEVELOPMENT SPECIFICATION: TRANSDUCER, FULL BRIDGE, STRAIN-GAGE, WELDABLE, RADIATION RESISTANT, GENERAL SPECIFICATION FOR (U). (Aerojet-General Corp., Sacramento, Calif. (USA)). 28 May 1965. 10p. Dep. NTIS $4.00.

This specification covers full bridge, weldable, radiation resistant, strain gage transducers which consist of two parallel sensing tubes attached to a weld flange with provision for completing the bridge wiring. (WHK)

**19794** (RN-DR-0047) NERVA TABLES FOR COPPER-CONSTANTAN THERMOCOUPLES. Chandon, H. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1965. 88p. Dep. NTIS $7.50.

During the development of copper-constantan thermocouples for the measurement of cryogenic temperatures on NRX-A1 and -A2 engines, it was necessary to prepare a component specification (AGC 42136, Rev. D) for the procurement of thermocouples. The specification contained a table of output voltages versus temperature. A table in increments of 1°F is adequate to define the output for each thermocouple to be delivered against a purchase order. A complete tabulation of output in 0.0001 millivolt increments from -6.1985 millivolts (-459.46°F) to 0 millivolt (32°F) and in 0.001 millivolt increments from 0 millivolt (32°F) to 20.819 millivolts (750.39°F) is presented for copper-constantan thermocouples with a 32°F reference junction. (WHK)

**19795** (RN-DR-0064) NERVA TABLES FOR CHROMEL-ALUMEL THERMOCOUPLES. Chandon, H. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 126p. Dep. NTIS $9.50.

During the development of chromel-alumel thermocouples for the measurement of cryogenic temperatures on the cold flow development test series, it was necessary to prepare a component specification (AGC 42136, Rev. D) for the procurement of thermocouples. The specification contained a table of output voltages versus temperature. A table in increments of 1°F is adequate to define the output for each thermocouple to be delivered against a purchase order. A complete tabulation of output in 0.0001 millivolt increments from -6.1985 millivolts (-459.213°F) to 0 millivolt (32°F) and in 0.001 increments from 0 millivolt (32°F) to 54.929 millivolts (2500.392°F) is presented for chromel-alumel thermocouples with a 32°F reference junction. (WHK)

**19796** (RN-DR-0065) NERVA TABLES FOR CHROMEL-CONSTANTAN THERMOCOUPLES. Chandon, H. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 160p. Dep. NTIS $11.00.

During the development of chromel-constantan thermocouples for the measurement of cryogenic temperatures on the cold flow development test series, it was necessary to prepare a component specification (AGC 42136, Rev. D) for the procurement of thermocouples. The specification contained a table of output voltages versus temperature. A table in increments of 1°F is adequate to define the output for each thermocouple to be delivered against a purchase order. A complete tabulation of output in 0.0001 millivolt increments from -9.8238 millivolts (-459.42°F) to 0 millivolt (32°F) and in 0.001 millivolt increments from 0 millivolt (32°F) to 75.119 millivolts (1800.11°F) is presented for chromel-constantan thermocouples with a 32°F reference junction. (WHK)

**19797** (RN-S-0439) NONNUCLEAR QUALIFICATION-EVALUATION TEST RESULTS ON ROSEMOUNT MODEL 134AJ RESISTANCE TEMPERATURE TRANSDUCER. Fox, H. A. Jr. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1967. 26p. Dep. NTIS $4.50.

Three resistance temperature transducers (AGC PN 1116474) were selected for testing from a shipment procured in accordance with paragraph 4.2.1 of AGC Specification 90088. They were modifications of a former design (AGC PN 248635) used successfully in past NRX tests. In addition to the qualification-evaluation tests performed, additional experiments and analyses were conducted to determine the thermal emf effects that result from the use of sheathed cable containing nickel-clad conductors. (auth)

**19798** (RN-TM-0595) FAILURE ANALYSIS OF XE-P FLUSH MOUNT THIN FILM-VAPOR DEPOSITED-STRAIN GAGE BRIDGE PRESSURE TRANSDUCER STATHAM MODEL PA812-750, AGC PN50390-1, SN66. Straddeck, J. T. Jr. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 25 Mar 1970. 26p. Dep. NTIS $4.50.

A Statham Instruments, Inc. Model PA812-750 (AGC P/N 50390-1, SN66) vapor-deposited thin-film strain gage pressure transducer was used during the XE series of tests to monitor the turbine inlet gas pressure. The transducer was installed on the engine and located on the turbine inlet line in the vicinity of the nozzle hot bleed port and was identified as parameter PT810..A. The transducer performed satisfactorily during EP 1 through 7 of the XE test series. However, during the cooldown period of EP 8, the transducer output exhibited an erratic drift and finally drifted negatively off scale. Efforts to reblance the transducer before EP 9 were unsuccessful and the parameter was identified as inoperative throughout the remainder of the test series. The results of the post mortem examination and failure analysis of PT 810 pressure transducer are presented. All the evidence indicated that the mode of failure was caused by a high voltage transient of unknown origin. (WHK)

**19799** (RN-TM-0598) EFFECTS OF CABLE SPLICES ON THERMOCOUPLE CHANNEL UNCERTAINTIES. Samuelson, R. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1970. 22p. Dep. NTIS $4.25.

A typical thermocouple circuit contains thermocouple cable splices between the measurement and reference junctions as well as several copper cable splices between the reference junction and the data system input. It should be noted that all wire samples having the same nominal composition do not possess identical emf-temperature characteristics. This should be obvious when one considers the impossibility of controlling exactly, the chemical and physical properties of wire. Thus, a typical thermocouple circuit employs several discrete wire sections, each of which will usually differ thermoelectrically from all other sections. The purpose of this discussion is to qualitatively describe how thermocouple data channel inaccuracy is affected by the presence of splices between dissimilar cable sections. (auth)

**19800** (WANL-TME-875) ACOUSTIC NOISE TESTS OF ACCELEROMETERS AND AMPLIFIERS. Loftus, W. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 Jul 1964. 16p. Dep. NTIS $4.00.

Experiments were performed to measure the acoustic noise sensitivity of peizoelectric accelerometers and cathode followers of the types used in the NRX-A1 cold flow test. Two additional piezoelectric accelerometer types under consideration for reactor tests and possible NRX application were also tested. The tests were run at the Westinghouse Research Sound Laboratory in an acoustic noise chamber designed and fabricated at this facility. (auth)

**19801** (WANL-TME-904) CALIBRATION SPECIFICATION FOR PRESSURE TRANSDUCERS. Burlas, T. C.; Karako, E. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 4 Aug 1964. 10p. Dep. NTIS $4.00.

This specification outlines the Westinghouse Astronuclear Laboratory (WANL) requirements for the calibration of all pressure transducers used for instrumentation. (auth)

**19802** (WANL-TME-905) ACCEPTANCE TEST SPECIFICATIONS FOR PRESSURE TRANSDUCERS. Burlas, T. C.; Karako, E. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 23 Sep 1964. 12p. Dep. NTIS $4.00.

This document outlines the Westinghouse Astronuclear Laboratory (WANL) specifications and procedures for acceptance testing

of differential and absolute pressure transducers. All pressure transducers used for reactor instrumentation shall meet the requirements of this specification before being accepted. (auth)

**19803** (WANL-TME-912) ACCEPTANCE TEST SPECIFICATIONS FOR ACCELEROMETERS. Burlas, T. C.; Karako, E. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Sep 1964. 13p. Dep. NTIS $4.00.

This document outlines the Westinghouse Astronuclear Laboratory (WANL) specifications and procedures for acceptance testing of accelerometers. All accelerometers that are to be used for reactor instrumentation shall meet the requirements of this specification before being accepted. (auth)

**19804** (WANL-TME-913) CALIBRATION SPECIFICATION FOR ACCELEROMETERS. Burlas, T. C.; Karako, E. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 Sep 1964. 13p. Dep. NTIS $4.00.

This specification outlines the Westinghouse Astronuclear Laboratory (WANL) requirements for the calibration of all accelerometers used for reactor instrumentation. (auth)

**19805** (WANL-TME-1176) INTERIM REPORT ON THERMOCOUPLE SHEATH DEVELOPMENT. Remley, G. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 19 May 1965. 10p. Dep. NTIS $4.00.

Progress in the development of reliable thermocouple sheaths for use in the NRX reactor is reported. (WHK)

**19806** (WANL-TME-1182) NON-NUCLEAR QUALIFICATION TESTING OF THE IMPROVED MODEL WIANCKO AX-44 ACCELEROMETER. Loftus, W. D.; Pappas, T. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Jun 1965. 31p. Dep. NTIS $4.75.

Results of the non-nuclear qualification testing performed on three improved model Wiancko AX-44 variable reluctance accelerometers (WANL Part No. 978D227H02B) are presented. These improved models were redesigned internally by the vendor in order to reduce the thermal sensitivity effects experienced with the earlier developmental models (Ref: WANL-TME-1060). In general, it can be stated that the improved models exhibit significantly better performance over the temperature range of −320°F to +600°F. Specific performance characteristics are as follows: (1) Linearity and Hysteresis—The combined error resulting from the effects of nonlinearity and hysteresis was less than ±1 per cent of full scale output over the temperature range of −320°F to +600°F; (2) Thermal Sensitivity Shift—The thermal sensitivity shift was less than ± 20 per cent of the room temperature value over the temperature range of −320°F to +600°F, and was found to be independent of acceleration level; (3) Frequency Response—The frequency response from 15 cps to 200 cps was flat to within ± 4 per cent over the temperature range of −320°F to +600°F; and (4) Thermal Shock—The percent sensitivity deviation during thermal shock from 75°F to −320°F was less pronounced than for the previously tested developmental units. Furthermore, temperature stabilization occurred in about four minutes as compared to ten minutes for the developmental units. This indicates that the new models have greatly improved internal heat transfer paths—an important factor with regard to dissipating radiation-induced heating. (auth)

**19807** (WANL-TME-2767) NUCLEAR SUBSYSTEM IN INSTRUMENTATION. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1971. 238p. Dep. NTIS $15.00.

This trade study evaluates candidate transducer and support equipment design concepts and makes a preliminary selection of the candidate or candidates which appear to be the most promising for further development to meet the flight measurement requirements for the NERVA Program. Candidate transducers are classified into three types which are dependent on the relationship of measurement requirements to transducer performance as presently known. Type A: The device selection has been made with expectation of performance within the given requirements; therefore, no development effort is required. This type includes low temperature resistance temperature transducers (RTT) and thermocouples, medium temperature thermocouples, and demodulators. Type B: The basic device concept has been selected with actual design to be determined from results of the development effort. This group includes only the cluster exit gas high temperature thermocouple. Type C: Various basic device concepts have been identified which show promise of meeting the desired requirements. The development testing effort will lead to final selection with confirmation resulting from prequalification testing. This type includes the core material high temperature thermocouples, support stem load transducers, in-vessel pressure transducers, vibration transducers, neutronic instrumentation, displacement transducers, acoustical transducers, and strain gages. (auth)

**19808** (ZFK-271, pp 195-199) COMPUTER KRS 4200 IN THE MULTICHANNEL ANALYZER MODE. Meiling, W. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The design and operation of a minicomputer for nuclear experiments is described. (JFP)

**19809** RADIATION CONVERTER PLATE DESIGN. Ash, M. S.; Yanow, G. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). Nucl. Sci. Eng.; 55: No. 3, 342-345(Nov 1974).

In certain atomic physics experiments performed in conjunction with underground nuclear-weapon testing, it is desired that radiation energy converter plates be irradiated so as to reemit a maximum amount of radiation. The plates, composed of thin layers of materials of differing atomic number, are to be designed by choosing the material atomic number for each layer so that the plate, in toto, produces minimum photoelectron kinetic energy. Minimum photoelectron kinetic energy implies maximum energy reradiated, in the context of the radiation energy spectral regime of interest. The optimum choice of layer atomic numbers involves the solution of a novel variational problem where the minimizing function, the atomic numbers, take on integer values only. A comparison is made between the optimally designed plate and the corresponding homogeneous plate in terms of photoelectron kinetic energy produced. The homogeneous plate produces more than two orders of magnitude more photoelectric kinetic energy than does the optimally designed plate. (auth)

**19810** COMPUTER CONTROLLED ION-COUNTING, ISOTOPE RATIO MASS SPECTROMETER. Schoeller, D. A. Bloomington, IN; Indiana Univ. (1974). 219p. University Microfilms Order No. 75-1755.

Thesis (Ph. D.).

A computer-controlled, ion-counting mass spectrometer system is described. This system was designed for measuring isotope ratios on submicrogram samples with a precision of 0.1%. The mass spectrometer accelerating voltage is scanned under software control; and the tasks of peak location, data acquisition and data reduction are computer automated. The scanning function used during the analysis, i.e., time spent counting on each peak is calculated in real-time as a function of the peak intensities with the purpose of minimizing the analysis time. Applications of this system at present include xenon isotope analysis, carbon isotope analysis on intact n-alkanes and differential carbon isotope analysis on $CO_2$. With the aid of a suitable standard, the system has been shown capable of detecting $10^{-3}$ atom percent excess of label incorporation. The differential carbon isotope analysis, which is the major application, has been demonstrated to have a precision and accuracy of 0.1% for samples as small as 100 ng C. This is a 100 fold decrease in the minimum sample requirements compared to that of a conventional dual collector Faraday cup instrument. (WHK)

**19811** MAXIMUM TEMPERATURE MONITOR. Hofman, G. L.; Hudman, G. D. (to United States Atomic Energy Commission). US Patent 3,851,527. 3 Dec 1974. Filed date 21 Jan 1974. 6p.

A passive temperature monitor is presented with two evacuated chambers interconnected by a restricted passageway. One of the chambers is charged with a measured amount of vaporizable substance which has a relatively low vapor pressure at the charging temperature. On heating the monitor, for instance, within a nuclear reactor coolant, the vapor pressure of the substance increases, thus increasing the portion of that substance in vapor phase throughout the two chambers. On cooling, the vaporized substance condenses, with a portion being trapped within the originally empty chamber. From the mass of that trapped portion, the maximum temperature occurrence can be determined. (Official Gazette)

# ISOTOPE AND RADIATION SOURCE TECHNOLOGY

## Isotope Separation (Industrial)

*Refer also to abstract 19828.*

**19812** (74-CNA-300, pp 3) PROGRESS REPORT ON AECL HEAVY WATER PLANTS. Smith, A. I. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-300.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 3. Heavy water.

Modification and reconstruction of Glace Bay Heavy Water Plant by Atomic Energy of Canada has involved limiting enrichment by the GS process to 20%, and putting in a vacuum distillation unit to yield 99.75% $D_2O$. Seawater has been eliminated, so it was necessary to dam a brook for fresh water. An 800 ton/year heavy water plant to be built in Quebec by 1978 will initially use steam from Gentilly-1 reactor, later from Gentilly-2. (INIS)

**19813** (74-CNA-300, pp 4) PROGRESS REPORT: PORT HAWKESBURY HEAVY WATER PLANT. Dougan, L. D. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-300.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 3. CANDU program and research installations.

In late 1972, Port Hawkesbury Heavy Water Plant (based on the bithermal $H_2O/H_2S$ exchange process) was functioning satisfactorily except for foaming in the three first stage towers, which limited production to 50% of design. Research was done, and foam was abated by lowering the height of the weirs in the towers and by treating the purified feedwater with activated carbon to remove surface-active substances. (INIS)

**19814** (74-CNA-300, pp 15) PROGRESS REPORT: BRUCE HEAVY WATER PLANT. Icely, R. F. U. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 3. Heavy water.

Bruce Heavy Water Plant, with a nominal capacity of 100 kg/h $D_2O$ was committed by Atomic Energy of Canada Limited, built by Lummus, and sold to Ontario Hydro in 1973 after attaining the designed production. The GS Process is used, in which water with 148 atomic ppm D is purified, stripped by counter-currents of $H_2S$ in enriching towers that have hot and cold sections, and then rejected. The $H_2S$ carries deuterium forward to two further stages that provide 20% enrichment, after which the deuterium is concentrated by distillation to 99.75% $D_2O$. Foaming in the enriching towers was the chief problem in commissioning the plant. By lowering the height of the weirs in Enriching Unit E1 and adding an antifoam, extraction was increased from 46 to 93% of designed capacity. Future research will try to eliminate the use of antifoam. The steam supply from Douglas Point Nuclear Generating Station is backed by an oil-fired system, so that little production has been lost for want of steam. (INIS)

**19815** (74-CNA-300, pp 33) RESEARCH AND DEVELOPMENT SUPPORT FOR HEAVY WATER PRODUCTION. Perryman, E. C. W. 1974.

From Canadian Nuclear Association 14th annual international conference, Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-300.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 3. CANDU program and research installations.

The large Canadian investment in heavy-water production justifies a large research and development support programme. The GS process used at present and in the forseeable future depends on deuterium exchange between water and hydrogen sulfide at two temperatures. Details of the first-stage towers are given. The process is very sensitive to operating variables such as liquid-to-gas flow ratios. The cold temperature is limited by formation of a hydrate of hydrogen sulfide below 28.9°C. Impurities in the feedwater, such as mercaptans in the hydrogen sulfide, or accidental contaminants such as oil from pump seals cause foaming in the towers. This foaming has hitherto been abated by adding antifoams dissolved in oil, which may cause problems; it is therefore intended to eliminate antifoams. Bruce Heavy Water Plant is highly instrumented, and its performance has been modelled on a computer. Corrosion, although not severe, merits and is receiving attention. Process modifications are being investigated. Research on the hydrogen/amine and hydrogen/water process is continuing; for the latter, "unwettable" siliconized platinum catalysts have been developed. The specific photoelectric bromination of a deuterated alcohol may possibly provide a highly efficient process in the future, but the photolysis requires an almost impracticable infrared source. (INIS)

**19816** (74-CNA-500, pp 6) URANIUM ENRICHMENT. Baroudi, M. Y. el. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 5. Impact of nuclear energy on industry.

The role of uranium isotope separation or enrichment facilities in the nuclear fuel cycle is identified. Following this, some of the technologies available for the isotopic separation of uranium are discussed. An outline is provided of the possible impact of the design, construction, and operation of a uranium enrichment plant in Canada. The impact on the engineering, construction and manufacturing industries as well as other parts of the nuclear fuel cycle industry is discussed. (INIS)

**19817** (K-Trans-75) POLICY OF THE CEA IN THE FIELD OF URANIUM ENRICHMENT. Leduc, C.; Besse, G.; Taranger, P. 1973. Translated from French. (CONF-7309132-1). 19p. Dep. NTIS $4.00.

From ASPEA symposium; Bern, Switzerland (18 Sep 1973).

This report consists of three papers presented at the ASPEA symposium, Berne, September 18, 1973. The papers are entitled: "French Technology in Gaseous Diffusion;" "EURODIF;" and "The CEA Commercial Policy in the Field of Uranium Enrichment." The first paper describes the operation and experience gained from the Pierrelatte Plant. The second describes the European Gaseous Diffusion Project. The third discusses CEA plans for using the Pierrelatte Plant to supply enrichment services to reactors needing enriched uranium before the EURODIF becomes operational. The policy of CEA on uranium enrichment as stated lends very strong support of EURODIF. (TFD)

**19818** (MLM-2182) STABLE ISOTOPE SALES: MOUND LABORATORY CUSTOMER AND SHIPMENT SUMMARIES, FY-1974. Eck, C. F. (comp.). (Mound Lab., Miamisburg, Ohio (USA)). 14 Feb 1975. Contract AT-33-1-GEN-53. 29p. Dep. NTIS $4.00.

A listing is given of Mound Laboratory's sales of stable isotopes of noble gases, carbon, oxygen, and nitrogen, for Fiscal Year 1974. Purchasers are listed alphabetically and are divided into domestic and foreign groups. A cross-reference index by location is included for domestic customers. Cross-referenced listings by isotope purchased are included for all customers. (auth)

**19819** URANIUM IN ROTATION—GAS CENTRIFUGES FOR URANIUM ENRICHMENT. Struck, W. M. A. N. (Maschinenfabrik Augsburg-Nuernberg); No. 5, 4-8(Apr 1974). (In German). 4 figs.; 1 tab.

The diffusion method, the separation nozzle method, the centrifugal technology, the extent of the centrifuge fabrication and a comparison of costs of different uranium enrichment methods is described. (GE)

**19820** URANIUM ENRICHMENT: ONE OF TODAY'S INDUSTRIAL REALITIES. Pecqueur, M.; Coates, J. H.; Mezin, M. (CEA, Paris). Rev. Fr. Energ.; 25: No. 265, 197-214(Aug 1974). (In French and English).

The present status of uranium enrichment is examined, i.e., balance of supply and demand and existing processes. Procurement strategies to be envisaged by the European producers of electricity, to supply the nuclear programs they have launched are discussed. The risk of a real lack of enrichment means at the beginning of the next decade justifies the EURODIF Project. The general design of the Tricastin plant is presented. (FR)

**19821** PROCESS FOR SEPARATING URANIUM ISOTOPES. Netherlands Patent Application 7216867. 12 Dec 1972. 13p. (In Dutch).

Priority 12 Jan 1972, USA.

A process for separating uranium isotopes, i.e. $^{235}UF_6$ from $^{238}UF_6$ utilizing shock separation techniques is described. The gaseous uranium hexafluoride is introduced at supersonic velocity into a circular duct. Within the supersonic parallel flow stream a number of hollow probes is placed at different dis-

tances along the axis of flow. The hollow probes having critical dimensions relative to the mean free path of the flow stream in front of the probes so as to cause a detached stationary shock to form ahead of each of the leading edges of the probes. The process gives much better results than the process according to which all the probes are placed in the same transverse plane. (INIS)

**19822** PRODUCTION OF HEAVY WATER. Hydrogen–Water Deuterium Exchange Over Platinum Metals on Carbon Supports. Sagert, N. H.; Pouteau, R. M. L. (Atomic Energy of Canada, Ltd., Manitoba). Platinum Metals Rev.; 19: No. 1, 16-21(Jan 1975).

Catalysts using suitably supported platinum show promise for the commercial production of heavy water. Carbons are potential primary supports for the platinum and metal-support interactions have been observed in this system. These interactions lower the chemical activation energy and increase the rate of reaction under conditions where it seems likely that the support donates electrons to the metal. (auth)

**19823** URANIUM ENRICHMENT IN THE LASER LIGHT. US Researcher Explains Technical Details of Isotope Separation by Optical Excitation. Bruns, K. Welt (Hamburg); No. 194, 8(Aug 1974). (In German).

Elementary uranium evaporates at 2200°C; an intensive monochromatic laser beam (yellow) is directed into a heated mixture of isotopes, where it excites one of the isotopes because of the different nuclear structure (nuclear excitation), a second laser beam (ultraviolet) is added. The excited atom loses one electron, which allows the isotope mixture to be separated by electrical or magnetic fields. (GE)

**19824** DEVICE FOR SAMPLING GAS WITHIN THE ROTATING BOWL OF A CENTRIFUGE. Lascoux, P. (to Commissariat a l'Energie Atomique). US Patent 3,860,167. 14 Jan 1975. Priority date 19 Jan 1972, France. 6p.

The sampling device comprises a stationary axial column adapted to support at least one transfer tube which is joined to a transverse scoop within a sampling chamber. The scoop is displaceable between a withdrawn position in which it is wholly contained within the column and an outwardly-extended position in which it projects from the column as a result of a relative displacement of the tube with respect to said column. By permitting the controlled withdrawal of the scoops into the stationary axial column to which they are connected, the device makes it possible to introduce and remove the column and the scoops through a narrow transfer opening. (Official Gazette)

**19825** DUAL TEMPERATURE EXCHANGE SYSTEMS SUITABLE FOR ISOTOPIC EXCHANGE. Spevak, J. S. (to Deuterium Corp.). US Patent 3,860,698. 14 Jan 1975. Filed date 22 Mar 1971. 22p.

A dual temperature exchange system is described wherein the feed supply substance traverses selected portions of one of the two temperature zones, said selected portions being correlated with the availability and/or cost of a supply of the feed substance concerned, e.g., (A) when a large supply of feed substance is available at relatively low cost, advantages are realized by directing at least a part of the feed-to-disposal path through only the region of the impoverishing tower wherein the feed substance has a concentration less than or substantially not greater than the concentration of the feed supply; (B) where a limited supply or a high cost supply of feed substance is involved or a high degree of extraction of the desired material from the feed supply of substance is desired, advantages are realized by employing cyclic circulation not only of the auxiliary fluid but also of the fluid maintained in exchange relation thereto, with correlated provision for enriching the two circulating streams with the desired material from a feed supply substance; combinations of (A) and (B) in such systems; a differential heat recovery arrangement; and provisions for increasing the output capacity of integrated enrichment systems without physical alteration of the intermediate and/or final enrichment stages thereof. (Official Gazette)

## Isotopic Power Sources

*Refer also to abstract 19463.*

**19826** (BNWL-1845-2) PACIFIC NORTHWEST LABORATORY MONTHLY REPORT ON SPACE NUCLEAR SYSTEMS PROGRAM FOR JULY 1974. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1974. Contract AT(45-1)-1830. 14p. Dep. NTIS $5.45.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of $^{90}Sr$ if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. Progress is reported on the following areas of research: $SrF_2$ compatibility tests; $SrF_2$ dissolution rates in aqueous media; $SrF_2$ physical property measurements; WESF $^{90}SrF_2$ capsule analysis; thermodynamic analysis of $^{90}SrF_2$ compatibility; and $SrF_2$ compatibility program plan. (TFD)

**19827** (BNWL-1845-4) PACIFIC NORTHWEST LABORATORY MONTHLY REPORT ON SPACE NUCLEAR SYSTEMS PROGRAMS FOR OCTOBER 1974. Fullam, H. T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1974. Contract AT(45-1)-1830. 29p. Dep. NTIS $4.50.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of $^{90}Sr$ if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. Progress on the following areas of research is reported: short-term compatibility tests, $SrF_2$ dissolution rate studies, thermodynamic analysis of $^{90}SrF_2$ compatibility, and the $^{90}SrF_2$-tungsten system. (TFD)

**19828** (MLM-1180) DESTRUCTIVE EXAMINATION OF A SNAP HEAT SOURCE. Wyder, W. C.; Powers, J. A.; Vallee, R. E. (Mound Lab., Miamisburg, Ohio (USA)). 25 Nov 1963. Contract AT(33-1)-gen-53. 19p. Dep. NTIS $4.00.

A detailed examination was made of one of three plutonium-238 fueled SNAP 3 heat sources which was shipped from Mound Laboratory in May 1961 and returned in May 1963. Examination of the source included radiography, calorimetry, dimensional inspection, radiation measurements, internal pressure measurements, metallographic examinations of the containers, and recovery and impurity analysis of the plutonium fuel. Results showed that the inner tantalum container of the source failed at the weld, allowing the plutonium to escape and to attack the Haynes Alloy 25 outer container. Failure at the weld was attributed to the fact that the plutonium had become molten at some time during its use and to poor welding of the liner during fabrication of the source, and not to corrosion of plutonium on the tantalum. It was concluded that tantalum is a satisfactory container material for plutonium at temperatures below the melting point of plutonium (~640°C). (auth)

**19829** RADIATION PROTECTION; HERE: LICENSING AND SURVEILLANCE PROCEDURE FOR THE HANDLING OF RADIONUCLIDE SOURCES IN CARDIAC PACEMAKERS. Circular Letter of MS of 3.1.1974 – II – 22.52.48 – GueltL 91/3. Niedersaechsisches Ministerialbl.; No. 4, 104-106(1974). (In German).

The full text of the recommendations (of the NEA) declared to be binding by the BMI (Fed. Ministry of the Interior), and the full text of the regulations to be applied in the Land Lower Saxony are presented. (GE)

**19830** GAMMA DOSIMETRY IN HEART STIMULATOR WITH $^{238}Pu$ THERMOELECTRIC BATTERY. Agelao, G.; Di Mariano, D.; Greco, G. (Univ., Palmero, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 3, 117-125(1974). (In Italian).

The study using thermoluminescent powders of LiF (TLD-100) to detect the gamma dose rate distribution on the surface of the first cardiac pacemaker implanted in Italy containing a $^{238}Pu$ fueled power supply is described. For the measurements dosimeters of 6.4 mm diameter each containing 22 mg of LiF were suitably prepared and calibrated. Twenty-two dosimeters on every face of the pacemaker were irradiated for 992 hours. The maximum of detected dose rate was 1.4 mrem/h. (auth)

## Radiation Sources

**19831** (74-CNA-400, pp 9) COMMERCIAL PRODUCTS IN THE EXPORT MARKETS. Hetherington, C. H.; Gay, H. G. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-400.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 4. Export market for nuclear products.

Export and domestic trading activities of the Commercial Products Division of Atomic Energy of Canada Limited are summarized. The main activity is the manufacture and sale of irradiation units and isotopes for medical and industrial use, but a prototypical $^{60}$Co radioisotope power source has been installed at a meteorological station at Resolute Bay, Canada. Four standard irradiation units for sterilizing medical supplies range from 2 MCi and 1.5 million cu. ft. ($42 \times 10^3$ m$^3$) downwards; 30 have been sold. AECL is collaborating with Compagnie Generale de Radiologie (of France) in producing and marketing the Therac line of linear accelerators for cancer therapy. Commercial Product's best known products are $^{60}$Co teletherapy units, of which over 1100 have been installed in hospitals all over the world. The Therasim 750 is a computerized simulator which uses low energy x-rays to define the location of a tumor and then controls the motion of a beam from a Theratron 780 of Therac 6 accordingly. (INIS)

## Industrial Uses

*Refer also to abstracts 19219, 19887, 19888, and 21292.*

**19832** (AED-CONF-74-440-002) MASS DETERMINATIONS ON PLANTATIONS BY ABSORPTION OF GAMMA-RADIATION. Kuehn, W.; Schaetzler, H. P. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Hannover (F. R. Germany). Inst. fuer Strahlenbotanik). 1974. 6p. (CONF-741068-3). INIS.

From annual meeting of the German Biophysic Society; Freiburg im Breisgau, F. R. Germany (2 Oct 1974).

With abstract.

With "artificial cereals" good results are obtained by the device described. The accuracy of the mass determination lies between 1 and 4%. Measurements on natural cereals have not yet been done. The mass attenuation coefficient changes a little due to the variation of the water content. The difference between the mass attenuation coefficient of the dry organic material (which is nearly equal to Plexiglas) and of the fresh one is only 4%. (0.182 cm$^2$/g for the dry material and 0.188 cm$^2$/g for water). A mean attenuation coefficient can only lead to an additional error of 2%, when the exact value is not known. The small difference of the attenuation coefficient of 4% is caused by the different Compton scattering cross-section of the dry organic material (8-9% hydrogen) and of water (11% hydrogen). Climatic influences on the measurement during field experiments could not be tested yet. Evidently, measurement during rainy weather will yield too high mass values due to the water on the plants. Weak to moderate winds blowing from one direction during measurement could have a positive influence on the result because the movement of culms around their normal position will statistically equalize the inhomogeneity of the density distribution. (auth)

**19833** (BARC-766, pp 67-79) APPLICATION OF GAMMA RADIATION FOR PRESERVATION OF SEAFOODS. 1974.

In annual report for 1973 of the Biochemistry and Food Technology Division.

Indian research efforts on the use of gamma radiation in combination with other preservative processes, e.g., freezing, drying, cooking, and canning, for preserving seafoods are briefly summarized. (TFD)

**19834** (IBVL-422) WORKING INTO CHIPS AND CRISPS OF IRRADIATED POTATOES. II. Buitelaar, N.; Pau, G. F.; Snijders, K. D. M. (Instituut voor Bewaring en Verwerking van Landbouwprodukten, Wageningen (Netherlands)). Dec 1973. 17p. (In Dutch). INIS.

During the storage season 1971-1972 renewed experiments were carried out with potatoes treated with $\gamma$ rays or a chemical sprout inhibitor on base of IP/CIPC. In the course of the storage period these potatoes were made into chips and crisps in normal factories. The aim of the experiment was: 1) to investigate the quality of the chips and crisps manufactured from irradiated potatoes at different intervals after irradiation; and 2) to let the processing industry gain experience with irradiated potatoes. The results of the experiments were not very promising where the manufacture of chips from Bintje was concerned, because of discoloration. The manufacture of crisps from irradiated Saturna potatoes was quite successful, provided the potatoes were not processed until a few months after irradiation. Apart from color, the following properties were tested: flavor, water content and fat content after frying, crispness. There was not much difference between irradiated and chemically-treated potatoes, but severe discoloration of the irradiated potatoes is prohibitive for their use on a large scale. (NL)

**19835** (STI/DOC-10/161) LABORATORY MANUAL ON THE USE OF RADIOTRACER TECHNIQUES IN INDUSTRY AND ENVIRONMENTAL POLLUTION. (International Atomic Energy Agency, Vienna (Austria)). Jan 1975. 120p. IAEA $6.50.

The experiments in this laboratory manual were developed for two short courses held at North Carolina State University in the summers of 1971 and 1973 and entitled "International Training Course on the Use of Radiotracer Techniques in Industry and Environmental Pollution." The experiments given are divided into three general types, detection, tracer, and environmental. Seven detection experiments are presented with emphasis on those fundamentals of radiation detection required in tracer applications. Seven basic experiments illustrating the most common engineering or industrial applications of radioactive tracers are included. Finally, two experiments illustrating the common uses of radioactive tracers in environmental applications are given. The theory presented is not intended to stand alone. References are given for each experiment that discuss the theory of the particular applications in much more detail. (TFD)

**19836** IRRADIATION OF DATES. Farkas, J.; Al-Charachafchy, F. Acta Aliment.; 3: No. 2, 151-180(1974).

The radurization of fresh dates has been attempted. The applicability of gamma rays to the manufacture of date syrup has been investigated. The Zahdi, Leiwi and Tabarzel varieties have been studied at different stages of ripening. The eating quality of fresh dates was not affected significantly by irradiation even by exposures of 270 and 540 krad. The duration of the softening process (after ripening) of dates was prolonged by low doses of 10 to 30 krad in the majority of the experimental batches. The after-ripening period was reduced both by 270 krad and by 540 krad as a result of shortening of the induction period (i.e., the time after which the date begins to soften). The microbial spoilage of khalaal Leiwi dates was considerably reduced by irradiation with doses above 90 krad. The dibis yield of fully rutab dates was considerably increased by irradiation with 375 to 2000 krad. The darkness and viable cell count of dibis pressed from irradiated dates were significantly lower than those of untreated dates. (Hung. Tech. Abstr.)

**19837** HIGH-RATE DIGESTER MIXING STUDY USING RADIOISOTOPE TRACER. Zoltek, J., Jr. (County Sanitation Districts of Los Angeles County); Gram, A. L. J. Water Pollut. Contr. Fed.; 47: No. 1, 79-84(Jan 1975).

The object of this study was to compare the relative effectiveness of three different high-rate digestion mixing systems. Two of the systems utilized forms of gas recirculation; the third relied on liquid sludge recirculation. The study was performed at the Joint Water Pollution Control Plant of the Sanitation Districts of Los Angeles County. This 350-mgd primary treatment plant is ideally suited for this experiment in that it contains three digesters, identical in physical dimensions, each mixed by one of the three different mixing systems. All of the digesters received raw sludge from the same source. A radioactive tracer was used to measure the degree of mixing because the heterogeneous and opaque nature of digesting sludge makes the use of dye or salt tracers impractical. A submersible radiation detector was used for sampling. No public health hazard was associated with the radioactive tracer because an isotope ($^{24}$Na) with a short half-life was selected ($^{24}$Na). The digester effluent was discharged to the sea, where extreme dilution further minimized the health hazard. (TFD)

**19838** EFFECT OF IONIZING RADIATIONS ON THE SHELF-LIFE OF TOMATOES AS A FUNCTION OF THEIR RIPENESS. Kovacs, E.; Vas, K. Acta Agron. Acad. Sci. Hung.; 3: No. 2, 123-131(1974).

San Marzano tomatoes in three different stages of ripening were treated with 1, 4, 16, 64, and 256 krad doses of gamma rays. Storage temperature was 6 to 8°C, relative humidity 75 to 85%. Radiation treatment of green and red tomatoes was found inexpedient because the former do not meet organoleptic requirements while the shelf-life of the latter was not substantially extended. The spoilage of pink-color tomatoes could be delayed by radiation doses of 4, 16, and 64 krad, but higher doses resulted in an unfavorable effect. The rate of weight loss of tomatoes in different stages of maturity can be reduced by irradiation. Radiation treatment at first softened the texture of the tomatoes but this effect diminished during further storage. Irradiation of tomatoes in the pink stage of ripening seems to be promising. (Hung. Tech. Abstr.)

**19839** PHYSICAL CHANGES IN IRRADIATED TROUT (SALMO GAIRDNERI). Awad, A. A.; Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). J. Food Sci.; 40: No. 2, 319-321(1975).

The effect of irradiation on the physical properties of fresh water trout (Salmo gairdneri) was studied. Whole gutted fish samples were vacuum packed in plastic film impermeable to oxygen and water vapor, irradiated with 10 MeV electrons and stored under crushed ice for a maximum duration of 14 wk. Radurization (0.25, 0.50 and 0.75 Mrad) and radappertization (1.5, 3.0 and 5.0 Mrad) dose levels were used. The physical properties of fish muscle samples were assessed by shear force (SF), water-holding capacity (WHC) and plasticity index (PI) determinations. In nonirradiated samples WHC decreased, PI increased and SF showed little change during the 4-wk storage period. Radurization had no significant effect on SF and PI while WHC values were slightly but significantly lower in samples irradiated at 0.75 Mrad. During storage no significant changes took place in SF values; however, a slight WHC decrease and a slight PI increase (in both parameters less than in nonirradiated samples) were found at advanced storage periods. Radappertization doses resulted in higher SF values and in lower WHC and PI values as compared to nonirradiated samples. (auth)

**19840** LIGHT METER WITH NUCLEAR LIGHT SOURCE. Schmidt, E.; Wiessner, W. (to Ernst Leitz GmbH). US Patent 3,856,416. 24 Dec 1974. Priority Date 27 Sep 1971, F. R. Germany. 4p.

A light meter having coordinated indicating elements such as a pointer, a coupling pointer and/or scale in which a nuclear light source is provided, either alone or in combination with external light especially for use in cameras is described. (Official Gazette)

# LIFE SCIENCES

## Radiation Effects on Biochemicals

*Refer also to abstracts 19277, 19290, 19558, 19858, 19913, 20003, 20007, 20066, and 20145.*

**19841** (AEC-tr-7602, pp 15-19) EFFECTS OF UV RAYS ON MONOLAYER SURFACES OF FATTY ACIDS. Tongur, A. M.; Volkova, M. S.; Pavlovskaya, T. E.; Beshenkovskaya, N. M. (Inst. of Biochemistry, Moscow). 1974. Translated from Radiobiologiya; 14: No. 4, 486-489(1974).

In Radiobiology.

It was established that uv irradiation at a dose of $12 \cdot 10^6$ erg/cm$^2$ induces negligible changes in the surface properties of fatty acids, palmitic and linoleic, expressed in a small increase in the area of their monolayers. It was shown that the saturated fatty acid palmitic acid, forming an interface between the enzyme peroxidase and the substrated reduced methylene blue, manifests negligible barrier properties, whereas thin surfaces of separation of an unsaturated fatty acid (linoleic) under the same conditions intensified the process of enzymatic oxidation of methylene blue. UV irradiation induces an intensification of the catalytic properties of linoleic acid and their manifestation in palmitic acid. (auth)

**19842** (AEC-tr-7602, pp 20-24) RADIOSENSITIVITY OF THE BASIC PATHWAYS OF BIOSYNTHESIS OF PYRIMIDINE NUCLEOTIDES IN THE TISSUES OF RATS. Koshcheenko, N. N.; Romantsev, E. F. 1974. Translated from Radiobiologiya; 14: No. 4, 490-493(1974).

In Radiobiology.

The influence of whole-body $\gamma$ irradiation of rats at a dose of 1000 R on the process of enzymatic conversion of 2-$^{14}$C-orotic acid to uridylic and cytidylic ribonucleotides in 105,000 g supernatant fractions of thymus, spleen, and liver tissues was studied. It was established that in the early periods after irradiation the synthesis of pyrimidine nucleotides in the hematogenic tissues is somewhat increased, while in the liver it is substantially stimulated; after 3-5 hrs in the liver it does not differ from the control, while in radiosensitive organs it is 30-40% suppressed; by the end of the first day in the thymus and spleen it is 15-30 and 70-80%, respectively, and in the liver 130-150% of the control level. Possible mechanisms of the radiation disruption of the basic pathway of biosynthesis of pyrimidine nucleotides in the mammalian tissues are discussed. (auth)

**19843** (AEC-tr-7602, pp 34-40) INFLUENCE OF IONIZING RADIATION ON THE FLUORESCENT CHARACTERISTICS OF HUMAN THYROGLOBULIN. Yangibaev, M.; Khakimov, P. A.; Saatov, T.; Khamidov, D. Kh. (Inst. of Biochemistry, Tashkent). 1974. Translated from Radiobiologiya; 14: No. 4, 501-506(1974).

In Radiobiology.

The fluorescent characteristics of thyroglobulin, $\gamma$-irradiated at doses of 10, 15, 30, 45, and 75 kR, were studied. With increasing dose of irradiation, the fluorescence intensity of thyroglobulin decreases, which is accompanied by a short-wave shift of the position of the maximum and a narrowing of the fluorescence spectrum of the protein. In irradiated thyroglobulin the temperature region of the conformational conversion disappears. When the thyroglobulin solution is heated above 30°C, the appearance of a second band in the fluorescence spectrum of this protein is noted, with a maximum at 390 nm, due to the presence of iodoamino acids in thyroglobulin. (auth)

**19844** (AEC-tr-7602, pp 137-139) RADIOSENSITIZATION OF DNA IN THE PRESENCE OF REDUCING AGENTS AND A CATALYST OF RADICAL REACTIONS. Fomenko, L. A.; Leont'eva, G. A.; Gaziev, A. I.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 579-581(1974).

In Radiobiology.

DNA from Bacillus subtilis was gamma-irradiated at a dose of 1.5 krad. Damage to DNA was determined by changes in the intrinsic viscosity of DNA denatured in alkali and by the transforming activity of DNA. Results are tabulated for changes in DNA in the presence of ligase, ascorbic acid, iron ions, and DOPA. (HLW)

**19845** EFFECT OF X-RAY IRRADIATION ON THE BIOLOGICAL ACTIVITY OF H-2$^d$ GLYCOPROTEIN. Orlowska-Bijak, M. A.; Kowalski, D.; Rossowski, W. (Inst. of Nuclear Research, Warsaw). Nukleonika: 19: No. 12, 1091-1097(1974).

The effect of x-ray irradiation in doses ranging from 2.5 up to 20 kilorads on the biological activity of H-2$^d$ glycoprotein was studied. Biological activity of H-2$^d$ glycoprotein was evaluated measuring the inhibition of cytotoxic effect. The loss of the biological activity of H-2$^d$ glycoprotein was found to be linearly dependent on the irradiation dose. The dose of 20 kilorads results in the loss of about 30 per cent of biological activity of H-2$^d$ glycoprotein. No changes were found in the electrophoretic pattern and hexoses content of x-irradiated H-2$^d$ glycoprotein up to 20 kilorads. (auth)

**19846** MECHANISM OF INTERACTION OF THE RADIOSENSITIZING AGENT TAN WITH RADIATION-INDUCED DNA AND DEOXYRIBONUCLEOTIDE RADICALS. Nakken, K. F. (Norwegian Radium Hospital, Oslo); Brustad, T.; Tomas, E. pp 37-53 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

The ability of the radiosensitizing compound TAN to interact with radiation-induced DNA-radicals, formed in irradiated aqueous solutions, was studied. It is shown that TAN interacts through covalent binding with DNA-radicals G = 1.7 ($N_2$) and G = 2.6 ($N_2O$). From studies of radioinduced interactions of TAN with the four separately irradiated deoxynucleotides it follows that TAN interacts through covalent binding with (a) OH-induced dTMP and dCMP radicals, and (b) $e^-_{aq}$-induced dTMP-radicals. TAN interacts also with radiation-induced DNA radicals in redox reactions, giving rise to 2,2,6,6, tetramethyl-4-piperidone-1-hydroxyl, the G-value being 1.6 ($N_2$), i.e., a yield similar to that observed for covalent binding. From irradiation experiments with each of the four deoxynucleotides, it follows that the redox reactions of TAN involve $e^-_{aq}$-induced dAMP and dCMP radicals. Furthermore, the redox reactions of TAN with OH-induced deoxynucleotide radicals can at most account for one-third of the total yield of the observed redox reactions. Thus, the data presented suggest that TAN is able to interact with, and thus modify, 50% of radiation-induced DNA radicals. (auth)

**19847** MOLECULAR MECHANISM OF RADIATION PROTECTION AND SENSITIZATION. Lohmann, W. (Institut fuer Biochemie, Munich). pp 115-121 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

A model is proposed in which an electron transfer reaction is evoked for describing the modification of the radiation damage. According to this concept, radiosensitization and protection are complementary events depending on the direction of the electron transfer: electron donating substances act as radioprotective compounds while electron-attracting substances act as radiosensitizers. The model is tested with experimental results published thus far and some additional experimental evidence is given in support of the hypothesis proposed. (auth)

**19848** NEW METHOD FOR EXTENDING THE DIFFRACTION PATTERN FROM PROTEIN CRYSTALS AND PREVENTING THEIR RADIATION DAMAGE. Zaloga, G.; Sarma, R. (State Univ. of New York, Stony Brook). Nature (London); 251: No. 5475, 551-552 (11 Oct 1974).

A problem hampering the x-ray analysis of protein crystals is damage caused by the x-ray beam, and another limiting factor has been resolution of the diffraction pattern. Studies are described in which it was found that styrene and other vinyl monomers can decrease the radiation damage by a factor of as much as 10, and also extend the diffraction pattern so that higher angle reflections can be measured. Crystals of Ig G immunoglobulin were used in the studies. Such crystals were very sensitive to radiation, and the diffraction pattern does not show any measurable reflections beyond a resolution of about 5.5Å. The crystals were grown in the presence of various amounts of concentrated styrene monomers added to the protein before crystallization. The treated crystals continued to diffract even after 150 hours in the x-ray beam and showed sharp reflections extending to a resolution of 4Å. Monomers such as chlorostyrene and methyl methacrylate were also used with similar results. It is proposed to calculate an electron density difference map for the treated and untreated crystal with a view to locating regions of styrene binding in order to endeavor to understand the mechanism of the protection. It is speculated that styrene monomers are trapped in the intermolecular volume of the crystal lattice and are polymerized by the x-radiation. The aromatic nucleus in styrene is a good energy trap and presumably scavenges the free radicals formed in the crystal, thereby reducing

radiation damage. It is also suggested that at low styrene concentrations a polystyrene cage surrounds regions of the protein molecule, limiting its movement and thus extending the diffraction pattern. (UK)

**19849** REDUCED BINDING OF NITRIC OXIDE IN IRRADIATED HORSE HEART MYOGLOBIN. Paul, P.; Kumta, U. S. (Bhabha Atomic Research Centre, Bombay). J. Agr. Food Chem.; 23: No. 1, 37-40(1975).

The ligand binding of nitric oxide with a 0.05 mM concentration of horse heart myoglobin was studied as a function of radiation dose. At 100 krads, the nitrosylmyoglobin (NOMb) peaks at 575 and 545 nm decreased by about 50% as against 20% at 410 nm. Formation of NOMb could not be detected at higher radiation doses. Evidence for conformational changes in the apoglobin moiety caused by irradiation is presented in terms of increased susceptibility to tryptic hydrolysis and changes in polyacrylamide gel electrophoretic pattern. (auth)

**19850** ESR AND ENDOR STUDIES OF THE PARAMAGNETIC CENTER STRUCTURE IN IRRADIATED SINGLE CRYSTALS OF GLYCYLGLYCINE HYDROCHLORIDE AT ROOM TEMPERATURE. Kuropteva, Z. V.; Krivenko, V. G. (Inst. of Biological Physics, Moscow). Stud. Biophys.; 44: No. 3, 197-213(1974). (In Russian).

The radicals induced by radiation in single crystals of glycylglycine hydrochloride were studied using both ESR and ENDOR spectroscopy. The radicals $\dot{C}H_2CONHCH_2COOH$ and $H_3^+NCHCONHCH_2COOH$ were found at room temperature in addition to $H_3^+NCH_2CONHCHCOOH$ observed earlier. In these experiments the constants of hyperfine interactions of protons of these stable radicals were determined. The two methods were in satisfactory agreement. The ENDOR line intensity as a function of the magnetic field magnitudes was examined to separate different radicals. (auth)

**19851** SOME CHARACTERISTICS OF THE ENZYME KINETICS WITH IRRADIATED SUBSTRATE. Murgoci, P. (Fundeni Hospital, Bucharest). Stud. Biophys.; 44: No. 3, 169-172(1974).

Some additional kinetic details are described about the anomalous behavior of the irradiated enzymic substrates in enzyme reaction. The enzyme model is the glucose-6-phosphate dehydrogenase reaction. The time bandwidth, the reaction kinetics as function of the irradiated substrate concentration and the abolition of the signals by the existence of product in the reaction mixture are presented. (auth)

**19852** THYMINE DIMERIZATION IN ULTRAVIOLET-IRRADIATED BACTERIA TREATED WITH ACRIFLAVINE. Forage, A. J.; Porten-Seigne, I. (Hammersmith Hospital, London). Photochem. Photobiol.; 20: No. 1, 81-83(Jul 1974).

The number of thymine dimers induced in bacterial DNA by uv at 254 nm with and without pretreatment with acriflavine was measured, and compared with the protective effect of acriflavine against killing. Acriflavine was precisely dose-modifying for killing, but not for dimer formation over the whole dose-range studied, thus giving further evidence for the suggestion that the protective mechanism can be attributed mainly to the inhibition of photoproduct formation, with only a small contribution from physical shielding. In the low dose range an approximately 10 fold greater dose of uv was required to induce the same number of dimers in the acriflavine-treated bacteria as in the untreated bacteria. This result correlated well with the survival studies over the whole dose range. With higher doses, a photosteady state was reached when 1.3% of the thymine bases was dimerized in the acriflavine-treated bacteria, as opposed to approximately 7% for untreated bacteria, supporting the suggested mechanism of the intercalated dye molecules shifting the equilibrium towards monomerization, by inhibiting dimerization. (UK)

**19853** RADIATION EFFECTS ON NAD AND DNA-METABOLISM IN MOUSE SPLEEN. Streffer, C.; Beisel, P. (Univ., Freiburg i. B.). FEBS (Fed. Eur. Biochem. Soc.) Lett.; 44: No. 2, 127-130(Aug 1974).

From 9th FEBS meeting; Budapest, Hungary (25 Aug 1974).

NAD pyrophosphorylase and the chromatin-bound NAD glycohydrolase decrease considerably in mouse spleen after low-dose x-irradiation. The dose dependence of the radiation effects on NAD metabolism and on DNA synthesis shows close parallels. These changes also occur at the same time after x-irradiation. (NL)

**19854** CROSS-SECTIONS FOR SOME TpT PHOTOPRODUCTS. Cremonese, M.; Gozzi, D.; Matzeu, M.; Onori, G. (Instituto Superiore di Sanita, Rome). Stud. Biophys.; 44: No. 2, 101-108(1974).

Starting from the reaction scheme proposed by Johns et al. (J. Mol. Biol. 9(1964) 503), the kinetics and cross-sections of some photoproducts of TpT irradiated by uv light, were investigated. A spectrophotometric technique was used, following the optical density by variations of a TpT aqueous solution as a function of dose and wavelength. The validity of the reaction scheme previously mentioned was confirmed and the measurements of the cross-sections for two photoproducts different from the TpT dimers were extended to a larger range of wavelength. (auth)

**19855** INDUCTION OF SINGLE-STRAND BREAKS (ALKALI-LABILE BONDS) IN BACTERIAL AND PHAGE DNA BY NEAR UV (365nm) RADIATION. Tyrell, R. M.; Ley, R. D.; Webb, R. B. (Argonne National Lab., IL). Photochem. Photobiol.; 20: No. 5, 395-398(Nov 1974).

Irradiation at 365 nm results in the induction of approximately $2.4 \times 10^{-6}$ and $1.2 \times 10^{-6}$ single-strand breaks (alkali-labile bonds) per $10^8$ daltons per J $m^{-2}$ in extracted phage T4 DNA and in Escherichia coli bacterial DNA, respectively. The rate of break induction in DNA of intact phage was approximately one-fourth that for extracted phage DNA. 2-aminoethylisothiouronium bromide-HBr protected against break induction in both phage systems. No breaks were induced in the DNA of bacteria irradiated under anaerobic conditions over the dose range tested. Possible induction mechanisms are suggested. Consideration was given to the relative importance of pyrimidine dimers and single-strand breaks in the bactericidal action of 365 nm radiation. (auth)

## Radiation Effects on Cells

*Refer also to abstracts 19558, 19890, 19891, 19895, 19950, and 20147.*

**19856** (AEC-tr-7602, pp 1-6) DYNAMICS OF THE REPAIR OF SINGLE-STRANDED BREAKS IN DNA AND SUBLETHAL RADIATION DAMAGES IN IRRADIATED EHRLICH'S ASCITES CARCINOMA CELLS AND THE INFLUENCE OF ACTINOMYCIN D ON THESE PROCESSES. Konoplyannikov, A. G.; Synzynys, B. I.; Saenko, A. S. (Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 475-479(1974). In Radiobiology.

After γ-irradiation at a dose of 3 krad, rapidly repaired single-stranded breaks arise in the DNA of Ehrlich's ascites carcinoma (EAC) cells. The time of half-elimination of single-stranded breaks in vivo is about 74 min. The half-recovery time of sublethals in vivo in EAC cells, determined by the method of dose fractionation (600 + 600 rad), is 75 min. The introduction of 0.1 μg/g actinomycin D 60 min before irradiation almost entirely suppresses the replication both of single breaks and of sublethal damages. It is suggested that the appearance of single-stranded breaks in the DNA of irradiated cells leads to events that increase the sensitivity of the cells to the subsequent influence of ionizing radiation. (auth)

**19857** (AEC-tr-7602, pp 77-83) COMPARISON OF THE BIOLOGICAL EFFECTIVENESS OF 20-MeV ELECTRONS AND 200-kV X RADIATION ACCORDING TO THE FORMATION OF CHROMOSOME ABERRATIONS IN CELLS OF AN EHRLICH'S TUMOR. Kozlov, A. P.; Akimov, A. A.; Moskalik, K. G.; Pertsov, O. L. (Inst. of Oncology, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 4, 536-540(1974). In Radiobiology.

For a comparison of the biological effectiveness of fast neutrons and x radiation we used a metaphase method of analysis of structural rearrangements of chromosomes of Ehrlich's tumor cells. It was established that fast electrons induce the same types of chromosome aberrations and approximately the same percent ratios in the tumor cells as 200 kV x radiation, but have a lower biological effectiveness than the latter. It is noted that with increasing dose of radiation and periods of fixation, the differences in the cytogenetic effectiveness of fast neutrons and x radiation decrease. The coefficients of the RBE lie in the range from 0.75 to 0.93. (auth)

**19858** (AECL-5018, pp 51-65) BIOLOGY BRANCH. Baldwin, W. F. Nov 1974.

In Biology and Health Physics Division progress report, July 1 – September 30, 1974.

Results are summarized from studies of biochemical, molecular, and genetic mechanisms involved in the repair of radiation injuries in cells. The radioinduced release of proteins, including exonuclease, from the cell wall of Micrococcus radiodurans was used as a probe to study the nature of the enzyme binding site. The possibility of using extracts of M. radiodurans to repair radioinduced DNA strand breaks in vitro was investigated. The excision repair of uv-induced lesions of DNA in cultured chick embryonic fibroblasts was investigated and a study was made of the genes

involved in the repair of injuries of bacteriophage T4 induced by uv or ionizing radiation. (CH)

**19859** (AED-CONF-74-221-009) CHROMOSOME ANALYSIS FOR THE DETECTION OF THE EFFECT OF SMALL RADIATION DOSES. Stephan, G. (Bundesgesundheitsamt, Neuherberg/ Muenchen (F. R. Germany). Abt. fuer Strahlenhygiene). 1974. 12p. (In German). (CONF-740662-7). INIS.

From 15th annual meeting of the Vereinigung Deutscher Strahlenaerzte e.V. on the authorized physician within the meaning of the radiation protection laws; Karlsruhe, F. R. Germany (14 Jun 1974).

With abstract.

Among the methods available so far for the quantitative evaluation of radiation effects, the analysis of the metaphase chromosomes, counting of dicentric chromosomes and ring chromosomes, proved to be the most successful, particularly in the evaluation of small doses. In order to obtain informative results in the case of small doses (≥ 50 rad), a lengthy and time-consuming procedure has to be carried out since irradiation with doses in this low range will induce only few structural chromosome aberrations. According to Evans, only $2 \times 10^{-3}$ of all the lymphocytes present in the human body will be detected when checking a number of 500 cells. So, although cytogenetic investigations after exposure to ionizing radiations, as a biological dosemeter, yield results with but a limited reliability, the data obtained so far on accidentally exposed persons still offer the possibility of evaluating the absorbed dose by counting the dicentric chromosomes in the lymphocytes. Compared with the conventional methods of chromosome staining, the recently developed methods of band coloration offer better chances of identifying single chromosomes. Furthermore, much smaller aberrations can now be detected due to the specific band coloration of every chromosome, whereas formerly these aberrations would have been left undiscovered. It has become possible now to establish and give evidence of connections between chromosome aberrations and certain diseases, which has been impossible so far by the conventional methods. (GE)

**19860** ELECTRON-AFFINIC SENSITIZERS FOR HYPOXIC CELLS IRRADIATED IN VITRO AND IN VIVO: CURRENT STATUS. Adams, G. E.; Asquith, J. C.; Watts, M. E. (Mount Vernon Hospital, Middlesex, Eng.). pp 1-12 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Many chemical compounds have the ability to differentially sensitize hypoxic bacterial and mammalian cells to the lethal effects of ionizing radiation. Although several different mechanisms of sensitization have been characterized, the great majority of radiosensitizers appear to be "oxygen mimics". In accordance with theoretical predictions it is now established that the relative efficiencies of these sensitizers are related directly to their electron affinities. This has therefore simplified the search for active compounds of potential value in radiotherapy. In the first section, examples from the literature are used to illustrate the development of electron-affinic sensitizers from early experiments with bacteria through to the demonstration of large effects in mammalian cells irradiated in vitro. Molecular mechanisms are then discussed in relation to suggested models for the normal oxygen effect in radiobiology. Results from radiation chemistry, studies on the cell-cycle dependence of sensitizers, and from cellular rapid mixing experiments are used to support the proposal that the electron-affinic sensitizers "mimic" at least some part of the oxygen effect. In the last section, the current status of chemical sensitization of hypoxic cells in vivo is assessed. Criteria for potential clinical radiosensitizers are: therapeutic doses well below toxic levels, slow metabolism, ability to penetrate poorly vascularized tumors and to reach the hypoxic regions therein, sensitization throughout, or early in, the cell cycle and ability to sensitize at the dose levels conventionally used in fractionated radiotherapy. In recent animal experiments, successful hypoxic cell sensitization has been demonstrated in three general types of system. These are normal cells subjected to artificial hypoxia, ascites tumors, and solid tumors containing a demonstrable hypoxic cell fraction. Results from these experiments are used as a basis for a speculative assessment of future clinical applications. (auth)

**19861** STUDIES OF SENSITIZERS OF HYPOXIC CELLS IN VITRO AND IN VIVO. Whitmore, G. F.; Rauth, A. M.; Gulyas, S.; Kaufman, K.; Bush, R. S. (Ontario Cancer Inst., Toronto). pp 13-24 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

The studies reported include both experiments in tissue culture and in experimental tumors with two compounds, the Mannich derivative of paranitroacetophenone (NDPP) and the nitroimidazole-Flagyl. In-vitro NDPP is an effective radiation sensitizer and its sensitization is limited to hypoxic cells. Initial in-vivo experiments, however, failed to demonstrate appreciable radiation sensitization except after direct injection into a tumor. More recent experiments have been concerned with the reason for this failure. These experiments have indicated that NDPP itself is an inefficient sensitizer but that under appropriate conditions it is converted to a more active form which itself ultimatively decays to a product which has little or no sensitizing ability. The loss of sensitizing ability is enhanced in the presence of serum proteins. Some experimental data bearing on the nature of the active compound are presented. More recent studies with Flagyl have indicated that it is also a sensitizer of hypoxic cells but whereas NDPP sensitizes at micromolar concentrations Flagyl requires millimolar concentrations and even at the solubility limit its sensitizing ability is appreciably less than NDPP. Preliminary in-vivo experiments indicate that Flagyl may produce appreciable sensitization of chronically hypoxic cells. (auth)

**19862** CELL CYCLE-DEPENDENT AND HYPOXIC RADIOSENSITIZERS. Berry, R. J.; Asquith, J. C. (Churchill Hospital Research Inst., Oxford). pp 25-36 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Cell cycle-dependent radiosensitizers such as Methotrexate, which show marked activity in mammalian cells in vitro at drug concentrations that can be achieved in vivo may still offer little additional effect against experimental tumors in vivo. This is explained in terms of a model of the growth kinetics of tumors in vivo. By contrast, selective sensitizers of hypoxic cells, which show activity in vitro in mammalian cells, even in the presence of a 100% serum medium, also show comparable radiosensitizing effects in hypoxic ascites tumor cells in vivo. This class of drugs offers greater promise for use in combination with radiotherapy. (auth)

**19863** EFFECT OF RADIOSENSITIZERS IN RELATION TO THE SIZE OF RADIATION DOSE FRACTION. Revesz, L. (Karolinska Inst. Medical School, Stockholm). pp 55-64 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Experiments performed to study the effect of an electron affinic radiosensitizer (triacetoneamine-N-oxyl, TAN) on the survival parameters of irradiated Chinese hamster cell cultures are reported. When exposures were made under oxic conditions, neither the extrapolation number (n) nor the slope-constant ($1/D_0$) of the survival curves was changed by TAN. In contrast, when exposures were made under anoxic conditions, both parameters increased as the result of TAN treatment. The effect of TAN on cellular recovery from radiation injury, suggested by these observations, was tested and proved in split-dose experiments in which the survival ratio between cells exposed to a single dose and the same dose divided in two fractions was in good agreement with the increase of the extrapolation number. The theoretical consequence that the extent of TAN sensitization is not constant, but may vary at different survival levels, was tested and proved experimentally by determining the survival ratio between TAN-treated and control cells after exposure to different, single doses. Reference is made to the consistent and contradictory observations reported in the literature, and possible explanations for the existing controversy are considered. The dependence of sensitization on the size of radiation dose fractions in clinical trials is discussed, including the suggestion that radiosensitizers that could replace oxygen should be combined with individual doses larger than those used in conventional radiotherapy. (auth)

**19864** STUDIES ON THE RADIATION-SENSITIZING ACTION OF NDPP, A SENSITIZER OF HYPOXIC CELLS. Whitmore, G. F.; Gulyas, S.; Varghese, A. J. (Univ. of Toronto). Radiat. Res.; 61: No. 2, 325-341(Feb 1975).

While in vitro studies indicate that NDPP is a very efficient sensitizer of hypoxic mammalian cells, studies using the KHT tumor in vivo have failed to produce significant sensitization except when the compound is injected directly into the tumor. In vitro studies, carried out to resolve this apparent discrepancy, indicate that NDPP is itself a rather inefficient sensitizer but undergoes conversion to a more active form. While this conversion occurs more rapidly under basic conditions, the maximum

conversion occurs at approximately 2 hr at pH 7.4. The studies reported here suggest that this active form binds to serum and cellular proteins as well as to small sulfhydryl-containing molecules such as glutathione. Based on the evidence presented it is suggested that the active form of NDPP is a dual-action type of sensitizer which acts partly because of its ability to bind SH groups and partly because of its electron affinic nature. (auth)

**19865** RATE OF STRAND SEPARATION IN ALKALI OF DNA OF IRRADIATED MAMMALIAN CELLS. Rydberg, B. (Uppsala Univ.). Radiat. Res.; 61: No. 2, 274-287(Feb 1975).

When mammalian cells are treated with alkali of pH at about 12, the cells are lysed and the released DNA starts to uncoil. This process of DNA strand separation is accelerated if the cells have been exposed to ionizing radiation, and the effect is clearly detectable in the dose range 10 to 100 rads. The rate of strand separation is also influenced by temperature and ionic strength of the alkaline solution. The kinetics of DNA strand separation in alkali is studied for three conditions in terms of ionic strength and temperature, chosen in such a way that the effect of irradiation may conveniently be studied in the dose range 10 rads to 20 krads. The accelerating effect of ionizing radiation on DNA strand separation is probably due to DNA strand breakage and the technique described is thus a sensitive method of studying such damage to DNA. A model for the strand-separation process, based on the assumption that strand breakage causes the accelerating effect, is proposed and found to describe the experimental data adequately. (auth)

**19866** HEAVY-ION IRRADIATION OF HUMAN AND CHINESE HAMSTER CELLS IN VITRO. Todd, P. W. (Los Alamos Scientific Lab., NM). Radiat. Res.; 61: No. 2, 288-297(Feb 1975).

Cultured human kidney (T-1) and liver (Chang) cells and Chinese hamster bone marrow (M3-1) cells were irradiated with heavy ions from the Berkeley heavy-ion linear accelerator, and their subsequent ability to grow into visible colonies was assessed. Heavy-ion inactivation cross sections were compared to microscopically measured nuclear cross section distributions found in cultures under the conditions of irradiation. Chinese hamster cells were found more resistant to all radiations studied within the linear energy-transfer range of 45–20,000 MeV-$cm^2$/g, and this higher resistance relative to the human cells appeared to correlate with the smaller nuclear cross-sectional area of the Chinese hamster cells. (auth)

**19867** SYNERGY BETWEEN THE ANTIMITOTIC ACTIVITY OF X RAYS AND URETHAN ON MOUSE BONE MARROW STEM CELLS (CFU). Jullien, P.; Pujol, P. (Institut du Radium, Orsay, France). Radiat. Res.; 61: No. 2, 316-324(Feb 1975).

Mouse bone marrow colony forming units (CFU) which survive an x-ray exposure are more sensitive to the antimitotic effects of urethan than unirradiated CFU. This enhanced sensitivity to urethan of CFU surviving x-irradiation seems unlikely to result from the conversion of ethyl carbamate into N-hydroxy-urethan, which is an inhibitor of DNA synthesis similar to hydroxyurea. (auth)

**19868** HISTOCHEMICAL AND BIOCHEMICAL STUDIES IN ULTRAVIOLET IRRADIATED TISSUE CULTURE. Bahuguna, L. M.; Chaturvedi, U. C. (K. G. Medical Coll., Lucknow, India). Brit. J. Exp. Pathol.; 55: No. 4, 314-319(Aug 1974).

Damage to subcellular organelles by ultraviolet irradiation of tissue culture was investigated by studying their marker enzymes using histochemical and biochemical techniques. It was observed that mitochondria, endoplasmic reticulum, plasma membranes, and lysosomes are affected by the ultraviolet light. The enzymes start showing alterations as early as 5 min after start of irradiation and the different enzymes diminish markedly by the third hour. It has been suggested that the alterations in the enzymes are due to effect on certain pathways and not to physical damage of subcellular organelles. (auth)

**19869** XERODERMA PIGMENTOSUM CELLS WITH NORMAL LEVELS OF EXCISION REPAIR HAVE A DEFECT IN DNA SYNTHESIS AFTER uv IRRADIATION. Lehmann, A. R. (Univ. of Sussex, Eng.); Kirk-Bell, S.; Arlett, C. F.; Paterson, M. C.; Lohman, P. H. M.; de Weerd-Kastelein, E. A.; Bootsma, D. Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 219-223(Jan 1975).

Cells cultured from most patients suffering from the sunlight-sensitive hereditary disorder xeroderma pigmentosum are defective in the ability to excise ultraviolet light (UV)-induced pyrimidine dimers from their DNA. There is, however, one class of these patients whose cells are completely normal in this excision repair process. We have found that these cells have an abnormality in the manner in which DNA is synthesized after UV-irradiation. The time taken to convert initially low-molecular-weight DNA synthesized in UV-irradiated cells into high-molecular-weight DNA similar in size to that in untreated cells is much greater in these variants than in normal cells. Furthermore, this slow conversion of low to high-molecular-weight newly synthesized DNA is drastically inhibited by caffeine, which has no effect in normal cells. Two cell lines from classes of xeroderma pigmentosum that are defective in excision-repair show intermediate effects, with regard to both the time taken to convert newly synthesized DNA to high molecular weight and the inhibition of this process by caffeine. (auth)

**19870** XERODERMA PIGMENTOSUM CELLS CONTAIN LOW LEVELS OF PHOTOREACTIVATING ENZYME. Sutherland, B. M.; Rice, M.; Wagner, E. K. (Univ. of California, Irvine). Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 103-107(Jan 1975).

Fibroblasts from patients with xeroderma pigmentosum contain low levels of photoreactivating enzyme in comparison to normal cells. Levels vary from 0 (line 1199) to 50 (line 1259) percent of normal. The depressed enzyme levels are not an artifact of low growth rate, age of cell donor, cell culture conditions, assay conditions, the presence of inhibitors, or mycoplasma contamination. It is shown that human fibroblasts can monomerize pyrimidine dimers in vivo. (auth)

**19871** GENETIC HETEROGENEITY IN XERODERMA PIGMENTOSUM: COMPLEMENTATION GROUPS AND THEIR RELATIONSHIP TO DNA REPAIR RATES. Kraemer, K. H.; Coon, H. G.; Petinga, R. A.; Barrett, S. F.; Rahe, A. E.; Robbins, J. H. (National Inst. of Health, Bethesda, MD). Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 59-63(Jan 1975).

Fibroblast strains from 12 patients with xeroderma pigmentosum had lower than normal rates of DNA repair, as determined by autoradiographic studies of ultraviolet-induced unscheduled nuclear DNA synthesis. The nuclei in binuclear cells, obtained by fusing fibroblasts from certain pairs of these strains, had a greater rate of DNA repair than the nuclei of either strain's unfused mononuclear cells. These results indicate that complementary corrections of the strains' repair defects had occurred in the fused cells. Four complementation groups were found, indicating that at least four mutations caused decreased DNA repair among these 12 strains. The unfused mononuclear cells of each group had a characteristic rate of repair that differed from the rates of the other groups. (auth)

**19872** SPONTANEOUS AND INDUCED MUTAGENESIS IN WESTERN EQUINE ENCEPHALOMYELITIS VIRUS IN CHICK EMBRYO CELLS WITH DIFFERENT REPAIR ACTIVITY. Dubinin, N. P.; Zasukhina, G. D.; Nesmashnova, V. A.; Lvova, G. N. (Inst. of General Genetics, Moscow). Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 386-388(Jan 1975).

Evidence was obtained indicating differences in the survival rate of Western equine encephalomyelitis virus after exposure to ultraviolet radiation and methyl methanesulfonate in commercial and leukosisfree chick embryo cells that differed in repair activity. The levels of spontaneous mutagenesis (on the basis of the yield of small plaque variants of the encephalomyelitis virus) did not essentially change when the virus was passaged in leukosis-free chick embryo cells, whereas an increase in the number of small plaque variants was observed in the cells of commercial chick embryos. A 10-fold increase in the number of induced virus variants was observed in commercial chick embryo cells in experiments with methyl methanesulfonate as compared with the control, whereas the induction of virus variants was not noted in leukosis-free cells. (auth)

**19873** COMPARATIVE PATHOLOGY OF CELLS TRANSFORMED BY HERPES SIMPLEX VIRUS TYPE 1 AND TYPE 2. Duff, R. (Pennsylvania State Univ., Hershey); Kreider, J. W.; Levy, B. M.; Katz, M.; Rapp, F. J. Nat. Cancer Inst.; 53: No. 4, 1159-1164(Oct 1974).

The morphology of hamster embryo cells transformed after infection with ultraviolet-irradiated herpes simplex virus type 1 (HSV-1) and herpes simplex virus type 2 (HSV-2) is described. A cell line developed after transformation by HSV-1 showed an epithelioid morphology, and cells transformed by HSV-2 resembled fibroblastoid cells. Epithelioid cells induced adenocarcinomas and fibroblastoid cells induced fibrosarcomas on injection of $5 \times 10^5$ cells into newborn hamsters. Cells isolated from these tumors and grown in culture retained a morphology similar to that of the original cells before animal passage. They were readily transplantable to weanling hamsters. The pathology of the tumors in weanling hamsters again corresponded to the morphology of the cell injected. (auth)

**19874** MITOTIC ACCELERATION INDUCED IN GRASSHOPPER NEUROBLASTS BY SMALL DOSES OF MONOCHROMATIC ULTRAVIOLET RADIATION. Carlson, J. G.; Stephens, R. E. (Univ. of Tennessee, Knoxville). Photochem. Photobiol.; 20: No. 1, 1-7(Jul 1974).

Neuroblasts of the grasshopper, Chortophaga viridifasciata (DeGeer), in culture were exposed to 4.15 J/m$^2$ of monochromatic ultraviolet radiation in middle prophase and timed to prometaphase (breakdown of the nuclear membrane). At wavelengths 265 and 280 nm the times recorded for the treated cells were significantly less than those for the matched control cells. Wavelength 225 nm produced neither significant acceleration nor deceleration of mitotic rate. Evidence from the present experiment did not implicate any particular chromophore in this response, though similar results of a previous microbeam study of neuroblasts pointed to the nucleic acid or protein of the nucleolus as the possible effective material. (auth)

**19875** CELLULAR AND MOLECULAR EFFECTS OF SOLAR ULTRAVIOLET RADIATION. Pollard, E. C. (Univ. of Florida, Gainesville). Photochem. Photobiol.; 20: No. 3, 301-308(Sep 1974).

Proceedings of the Conference are briefly summarized. Consideration of environmental questions, such as the increase in solar radiation that would be expected to follow any depletion of the ozone layer in the upper atmosphere followed an assessment of the basic physical factors involved in radiation reaching the earth. Studies of the biochemical aspects of the effects of uv irradiation, together with damage and repair mechanisms, and the mutations in microorganisms, were described by various contributors. The human implications of any increase in solar radiation in terms of effects, such as a greater incidence of skin cancers and damage to the eye, were also assessed. (UK)

**19876** EFFECT OF FRACTIONATED DOSES OF X-RAYS ON MITOTIC RECOVERY IN HeLa CELLS. Siracka, E. (Cancer Research Inst., Bratislava). Neoplasma; 21: No. 6, 671-677 (1974).

Changes in mitotic frequency were investigated in HeLa cells after repeated doses of x irradiation in the range 25 to 200 R. The second dose was applied at the time of the morphological restitution of the mitotic activity. After the second dose no substantial variations were observed in the onset of the mitotic depression and its duration, when compared to the effect of the first dose. The rate of mitosis after the repeated dose of irradiation exhibited, however, slowed increase which suggests that the repair capacity has not been fully restored in consequence of radiation-induced disorders in energy providing processes in cells. (auth)

**19877** FATE OF PYRIMIDINE DIMERS IN THE DNA OF ULTRAVIOLET-IRRADIATED CHINESE HAMSTER CELLS. Humphrey, R. M. (Univ. of Texas, Houston). Photochem. Photobiol.; 20: No. 3, 221-226(Sep 1974).

As an aid to understanding the relationship between dimer repair and cellular recovery, dimer removal and replication of dimer-containing DNA in Chinese hamster ovary (CHO) cells irradiated with ultraviolet light (254 nm) was studied. These investigations demonstrated that dimers were not excised as polynucleotides of less than 500,000 mol. wt, fractionation of the ultraviolet dose did not enhance dimer excision, dimer-containing DNA was replicated in ultraviolet-irradiated CHO cells, and the dimers were conserved in the replicated DNA. These findings supported the proposed mechanism of bypass of photoproducts during DNA replication in mammalian cells. (auth)

**19878** SYNERGISTIC EFFECT OF X-RAY AND UV IRRADIATION ON THE FREQUENCY OF CHROMOSOME BREAKAGE IN HUMAN LYMPHOCYTES. Holmsberg, M. (Research Inst. of National Defense, Stockholm); Jonasson, J. Mutat. Res.; 23: No. 2, 213-221(May 1974).

Human lymphocytes in the $G_0$ stage were irradiated with uv light and x rays. A 2-fold increase in the yield of dicentrics was observed in comparison with the yield for x rays alone. This synergistic effect was constant irrespective of the variation in the uv dose between 50 and 100 erg/mm$^2$. The individual chromosomes participated in interchange aberrations as expected from a random distribution per mitotic chromosome length unit. This observation is in contrast with the recent finding that x-ray-induced chromosome-type breakage is preferentially located on chromosomes with relatively large amounts of R-bands. Thus, the present data indicate that the additional breakage points, due to the synergism, had a different distribution between chromosomes from those induced by x-irradiation alone. Mechanisms that could account for the synergistic reaction are discussed. (NL)

**19879** PREMATURE CHROMOSOME CONDENSATION. I. Visualization of X-Ray-Induced Chromosome Damage in Interphase Cells Fused Cells. Hittelman, W. N.; Rao, P. N. (Univ. of Texas, Houston). Mutat. Res.; 23: No. 2, 251-258(May 1974).

A method is described to visualize chromosome damage in interphase cells immediately after exposure to mutagenic agents. This method involves the fusion of treated interphase cells with untreated mitotic cells, which results in the induction of premature chromosome condensation (PCC). Chinese hamster ovary (CHO) cells were treated with x rays and chromosome aberrations were scored in G2-PCC and the mitotic chromosomes. The incidence of aberrations was significantly higher in PCC than that observed in the mitotic chromosomes of the treated cells. Post-irradiation incubation for 1 h before fusion allowed the repair of some of the chromosome damage. Data are also presented, which indicate that the extent of radiation damage visualized in PCC is inversely proportional to the degree of chromosome condensation. These results indicate that the PCC method has a greater sensitivity in the detection of induced chromosome damage than the standard method of scoring metaphase chromosomes. (NL)

**19880** OER FOR MIXED NEUTRONS AND $\gamma$ RAYS. Katz, R.; Sharma, S. C. (Univ. of Nebraska, Lincoln). Brit. J. Radiol.; 47: No. 563, 823(Nov 1974).

The validity of a formula for the OER in a mixed field of neutrons and gamma rays (Hall, E. J., 1972a, British Journal of Radiology, 45, 284-288; 1972b, Ibid., 45, 628) was investigated for neutrons of different energies. The effects of neutrons (0.5, 1.0, 2.0, 14 MeV, and mean energy 7.5 MeV having the energy spectrum of the Hammersmith Hospital generator) on different cells (HeLa, leukaemia, human kidney) at a range of survival levels from 1 to 90 per cent were investigated. The values of $O_{mix}$, the OER for the mixture of neutrons and $\gamma$ rays, were within 5 per cent of those found from the Hall formula, suggesting that the formula may be used with confidence for neutrons of different energies, and for pions. (UK)

**19881** DETERMINATION OF RBE VALUES FOR FAST NEUTRONS AND NEGATIVE $\pi$-MESONS USING FROZEN HeLa CELLS. Nias, A. W. H. (Christie Hospital and Holt Radium Inst., Manchester, Eng.); Greene, D.; Major, D.; Perry, D. R.; Reading, D. H. Brit. J. Radiol.; 47: No. 563, 800-804(Nov 1974).

HeLa cells were irradiated with 300-kV x rays, 14-MeV neutrons and negative $\pi$-mesons (pions) at liquid nitrogen temperature, a condition where there was no recovery from sublethal damage so that effects of radiation delivered at low dose-rate could be compared without the complication of proliferation during the actual irradiation. After irradiation the cells were thawed and assayed for survival of colony-forming ability. Dose-response curves could be fitted to a common extrapolation number of 2.06. The $D_0$ values were: 677 rads, x rays; 364 rads, pions; and 181 rads, neutrons. Under the conditions of these experiments, therefore, the RBE of pions (at the ionization peak) was 1.86 and of neutrons was 3.73. (auth)

**19882** STUDIES ON THE RADIOSENSITIZING EFFECT OF OXYGEN IN CHINESE HAMSTER CELLS. Chapman, J. D.; Dugle, D. L.; Reuvers, A. P.; Meeker, B. E.; Borsa, J. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Int. J. Radiat. Biol.; 26: No. 4, 383-389(Oct 1974).

If DNA is to be considered as the critical target for radiation-chemical damage within a cell resulting in reproductive death, then the concentration range of oxygen over which radiation damage in cellular DNA is enhanced should correspond to the concentration range over which loss of clonogenic capacity is enhanced. A study of the kinetics of the oxygen effect on the loss of reproductive capacity and on the production of strand breaks (chemical lesions) in the DNA of Chinese hamster cells after x-irradiation demonstrated that the two were essentially the same. Other evidence for the radiation-chemical mechanism of the oxygen effect suggested by these results is discussed. (UK)

**19883** INDUCTION OF SPECIFIC RESISTANCE IN SWISS RATS WITH X-IRRADIATED CELLS OF THE ASCITE TUMOR ATPC+. Marconi, P.; Fimiani, E.; Bistoni, F.; Latini, A. (Univ. Perugia, Italy). Boll. Soc. Ital. Biol. Sper.; 49: 529-533(1973). (In Italian).

A study was made to determine if x-irradiated cells of the ascites tumor ATPC+ maintain any vaccinating capacity in Swiss rats. The ATPC+ was exposed to x-ray doses of 3,000, 6,000, and 12,000 R and then introduced by intraperitoneal injection into the rats. The results showed that the minimum dose for the prevention of tumor development was 6,000 R. Vaccinated animals, injected on the 30th day with ATPC+ cells, show a high degree of resistance to the tumor development. Antibodies appearing only in immunized animals are associated with a delay in the tumor growth. (JSR)

## Radiation Effects on Microorganisms

*Refer also to abstracts 19213, 19852, 19855, 19858, 19872, 19950, and 20007.*

**19884** (AEC-tr-7602, pp 25-33) PRINCIPLES OF THE FORMATION OF RADIO RACES IN YEAST ORGANISMS. Communication 6. Evaluation of the Mutability of Clones Growing Out of Irradiated Cells. Korogodina, Yu. V.; Korogodin, V. I. (Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 494-500(1974).

In Radiobiology.

Under the action of the $\gamma$ rays of $^{60}Co$, the survival curve of diploid yeasts Saccharomyces cerevisiae (strain 6PZ), homozygous with respect to the mutation $ade_{1-6}$ is sigmoid ($n = 3.0$, $D_0 = 14.6$ krad). The colonies growing out of irradiated cells vary in size, shape, and content of saltants (morphological variants and respiratory mutants). For an evaluation of mutability we used clones growing out of cells irradiated at a dose of 60 krad (survival ~5%). The controls were clones isolated from nonirradiated cells. In the control (clones of nonirradiated cells), the frequency of appearance of revertants per cell per division was $(1.21 \pm 0.07) \cdot 10^{-7}$. Directly in the irradiated cells, the frequency of revertants increased. In 40 clones, isolated from the irradiated material, the mutability differed little from the control. No correlation could be established between the level of mutability, the degree of morphological instability, and the instability with respect to the appearance of respiratory mutants. (auth)

**19885** (AEC-tr-7602, pp 84-88) RADIOSENSITIVITY OF BACTERIA (VIBRIOS). Sokurova, E. N. (Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 541-544(1974).

In Radiobiology.

The radiobiological characteristics of vibrios were obtained for the first time. It was shown that vibrios, in all probability, are one of the most radiosensitive taxonomic groups of bacteria. The sensitivity of vibrios to $\gamma$ rays is comparable with the response to irradiation of the radiosensitive mutant E. coli $B_{s-1}$. Two of the four investigated strains of vibrios give exponential survival curves, and two give curves with a short shoulder region. The values of $D_0$ are 1.4 to 2.1 kR. At doses of irradiation giving 1-2% survival or lower, the bulk of the cells of all the investigated vibrios die without division, or more rarely at the stage of two to four cells or at the stage of microcolonies consisting of 5 to 20 cells. Under the conditions of the experiments conducted, the vibrios practically do not form filaments. (auth)

**19886** (AEC-tr-7602, pp 162-166) STATISTICAL ANALYSIS OF THE KINETICS OF RADIATION DAMAGE TO POPULATIONS OF UNICELLULAR ORGANISMS. Communication 1. The Entropy Characteristic as an Index of the Kinetics of Growth of Irradiated and Nonirradiated Yeast Cells. Benevolenskii, V. N.; Kapitonenko, V. V.; Laptev, V. G. 1974. Translated from Radiobiologiya; 14: No. 4, 597-600(1974).

In Radiobiology.

A cell suspension of Saccharomyces ellipsoides was given 5 to 100 kR gamma radiation. After irradiation cells were transferred to agar and colony formation was observed. The forms of microcolonies and number of cells per colony were recorded. A formula is given for determining entropy characteristics. Radiation damage to cells as a function of physical parameters of irradiation, the type and time of observation of the recordable response and the initial state of the population can be quantitatively evaluated with the aid of the entropy characteristic. (HLW)

**19887** (BARC-766) ANNUAL REPORT FOR 1973 OF THE BIOCHEMISTRY AND FOOD TECHNOLOGY DIVISION. (Bhabha Atomic Research Centre, Bombay (India)). 1974. 142p. Dep. NTIS (US Sales Only) $10.25.

Separate abstracts were prepared for two of the ten sections in this report. The other eight sections discuss the following topics: regulation of protein function; control of transcription and translation; subcellular organelles and biomembranes; cellular differentiation and dedifferentiation; nutritional and metabolic studies; preservation of fruits, vegetables, and grains; flavor chemistry; and wholesomeness evaluation. (ERB)

*For abstracts of individual sections see: 19833 and 19888.*

**19888** (BARC-766, pp 79-90) MICROBIOLOGICAL ASPECTS OF IRRADIATED FOODS. 1974.

In annual report for 1973 of the Biochemistry and Food Technology Division.

The microorganisms associated with the spoilage of fish and meat products and the variations in their sensitivity to various radiopreservation regimes are discussed. (ERB)

**19889** BIOLOGICAL IMPORTANCE OF RADIATION-INDUCED DNA SINGLE-STRAND BREAKS: EFFECTS OF OXYGEN AND OF ORGANIC NITROXYL FREE RADICALS. Johansen, I. (Univ., Oslo). pp 65-76 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

To elucidate the role of DNA strand breakage in x-ray inactivation a comparison was made between effects of the radiation sensitizers, oxygen and N-oxyls, on x-ray-induced cell killing and DNA strand breakage. A repair-proficient strain of Escherichia coli K12, AB 1157, was sensitized 6.3 times by oxygen. Derivative strains carrying the recA13 mutation or the recA13, uvrA6 double mutations were sensitized 1.8 times and 1.45 times, respectively, by oxygen. However, both repair-proficient and repair-deficient strains were sensitized to half the maximal level by 8 $\mu$M of oxygen. Thus, on a molar basis the effectiveness of oxygen in cell killing is independent of functional gene products from the recA13 and uvrA6 loci. Tetramethylpiperidinol N-oxyl(TMPN) sensitized the anoxic recA13 mutant strain 4.6 times. Owing to this property it was demonstrated that, when present together, oxygen and TMPN competed in effects on cell killing. Oxygen reacted 30-40 times more readily with potentially lethal radiation-induced radicals than did TMPN. Strand breaks in the DNA were measured on intracellular phage $\lambda$ DNA molecules. An oxygen effect in DNA strand breakage was demonstrated when the cells were irradiated and transferred to an alkaline detergent at pH 12, all within 100 ms. This suggests that the oxygen effect in DNA strand breakage reflects an initial difference in the number of breaks formed in oxygen and nitrogen. The effective concentration of oxygen in DNA strand breakage was 0.5 $\mu$M, or 16 times lower than the effective concentration of oxygen in cell killing. TMPN neither increased the frequency of radiation-induced strand breaks in DNA nor hindered oxygen in promoting DNA strand breaks. This comparison allows a distinction to be made between radiation-induced radicals responsible for lethality and radicals responsible for DNA strand breakage owing to their different chemical properties. (auth)

**19890** RADIOSENSITIZING EFFECT OF QUINONE AND ARYLGLYOXAL COMPOUNDS. Astudillo, M. D.; Sanz, F.; Alvarez, M. V.; Partida, P. G. (Inst. of Physical Chemistry, Madrid). pp 77-86 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Seven quinones were studied as radiosensitizing agents: Diphenylquinone (DQ), Hydroxybiphenyl, p-Quinone, 1,2-Naphthaquinone, 1,4-Naphthaquinone, Vitamin $K_1$, and Anthraquinone. Preliminary experiments were carried out on yeast cells and the sensitizing capacity of the compounds was determined in both aerobic and anaerobic media. At 20% survival, the potentiation factors varied from 0.42 to 1.25 in air and from 1.20 to 2.80 in nitrogen. The first of these compounds was then selected for detailed studies on mice, implanted tumors (Ehrlich ascitic cells) and solid tumors (mammalian adenocarcinoma) because of its electronic structure and high potentiation factor in a cellular system. In the animal organism the potentiation factor was as high as 2.16 even though the carrier in which the DQ was administered had a strong radioprotective effect. In solid tumor (unirradiated) DQ caused selective local necrobiosis. It inhibited the live weight growth of mice inoculated with Ehrlich ascitic cells, and resulted in a decreased mitotic index and a high proportion of vacuolated and pycnotico-necrotic cells. A comparative study was also made of the effects of DQ on two types of tumor, in both irradiated and unirradiated animals. Similar methods were used to study four arylglyoxal compounds in yeast cells. The potentiation factors of these compounds in nitrogen at 20% survival were: phenylglyoxal 1.57, diphenylglyoxal 1.40, diphenylglyoxal 1.40, diphenylglyoxal-peroxide 2.28, and difuranylglyoxal 1.16. The relationship between radiosensitizing activity, redox potential and electron affinity of the compounds is discussed. (auth)

**19891** MOLECULAR MECHANISM OF RADIOSENSITIZATION BY IODINE-CONTAINING COMPOUNDS. Quintiliani, M. (Istituto Superiore di Sanita, Rome). pp 87-103 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Radiosensitizing iodine containing compounds, whose activity has been demonstrated on a variety of biological systems and end-points, ranging from enzyme inactivation to lethality in mammals, include many different species, which show no obvious common chemical and pharmacological properties apart from the presence of iodine in their molecules. However, since only a few of them have been extensively tested, it remains to be established whether a common mechanism of action can be postulated. Single-cell-system experiments, which so far have been almost exclusively confined to bacterial cells, strongly support the hy-

pothesis of a sensitizing mechanism, which operates through the agency of the radiolysis products of iodine compounds. These attack cells from the external medium, mainly reacting with the protein component of cellular membranes. The radiolysis active products appear to be iodine-containing free radicals. Experiments at the molecular level, using enzymes in solution as target molecules, appear to provide promising models for investigating the details of the mechanism of sensitization. The interest in radiosensitization by iodine compounds in view of possible applications is discussed. (auth)

**19892** REPAIR OF X-RAY DAMAGE TO BACTERIAL DNA AND ITS INHIBITION BY CHEMICALS. Kaplan, H. S. (Stanford Univ., CA). pp 123-142 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Abundant evidence indicates that DNA is the principal target of radiation damage leading to cell death. Ionizing radiation produces several kinds of damage in DNA: breaks in one or both polynucleotide strands and chemical alterations in the base and sugar moieties. DNA strand breaks differ, as a function of the exact sites of free radical attack, in the extent of the strand disruption and in the chemical nature of residual end groups. Different enzyme systems are thus required to repair different types of damage. Because it is the lesion most readily quantified, single-strand breakage and its repair have been most extensively studied in bacterial (and mammalian) cells. Failure to repair single-strand breaks, in cells in which repair is genetically or physiologically deficient or has been inhibited by certain chemicals, is associated with significant augmentation of cell lethality. Integrated studies of cell killing and of the yield of single-strand breaks in wild-type and selected mutant strains of Escherichia coli under a wide spectrum of experimental conditions have established the existence of at least three operationally distinct processes for the repair of single-strand breaks. Type I repair, the fastest, is complete in less than one minute at 0°C and preferentially rejoins breaks produced under anoxic conditions, thus leaving about one-third as many single-strand breaks remaining in cells irradiated under anoxic versus aerobic conditions. Indirect evidence implicates the enzyme DNA polynucleotide ligase in Type I repair. Most of the remaining breaks are repaired by the Type II process, which is complete in 5 min or less in buffer at room temperature and is deficient in polA mutants lacking DNA polymerase I and, to a lesser extent, in dnaE ts mutants at temperatures restrictive for DNA polymerase III. Finally, a limited number of residual breaks are repaired by the relatively slow Type III process, which requires 30-60 min in growth medium at 37°C, is absent or deficient in recA, recB, recC, and exr mutants, and may be inhibited following irradiation by exposure of cells to several different classes of chemical agents. Unlike the Type I process, both Type II and Type III repair apparently act to an equal degree on breaks produced under anoxic or aerobic conditions. (auth)

**19893** IONIZING RADIATION-INDUCED RELEASE OF A CELL SURFACE NUCLEASE FROM MICROCOCCUS RADIODURANS. Gentner, N. E.; Mitchel, R. E. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Res.; 61: No. 2, 204-215(Feb 1975).

Micrococcus radiodurans possesses an exonuclease (orthophosphoric diester phosphohydrolase EC 3.1.4.1) bound to its cell surface. Exposure to ionizing radiation causes release of this activity into the surrounding medium; less than 10% remains cell associated after 400 krad dose (sublethal). This enzyme is not normally excreted. The extent of release is a function of total ionizing radiation dose only, and is independent of dose rate or temperature. This enzyme is not involved in the post-irradiation DNA degradation that accompanies repair in this organism. A 5′-nucleotidase also located in the cell envelope is not released under these conditions. Since only a small amount of the total cell protein is released, an initial enzyme purification of about 150-fold could be achieved relative to crude extracts. (auth)

**19894** STUDIES OF PARACHLOROMERCURIBENZOATE-INDUCED RADIOSENSITIZATION IN ESCHERICHIA COLI AND BACTERIOPHAGES. Ho, Y. L.; Ho, S. K. (Loma Linda Univ., CA). Radiat. Res.; 61: No. 2, 230-238(Feb 1975).

Treatment of Escherichia coli B/r and $B_{s-1}$ with parachloromercuribenzoate (PCMB) causes marked increases (a maximum of about 16- to 20-fold) in the gamma radiation-induced single-strand breaks in DNA with the attainment of the same high limiting yield (of the order of $3 \times 10^{15}$ breaks/gDNA/krad) as that reported previously for E. coli 15T⁻. The amount of breaks in cells pretreated with $5 \times 10^{-4}$ M PCMB and subsequently washed five times prior to irradiation is comparable to that obtained with cells irradiated in $5 \times 10^{-5}$ M, thus suggesting sensitization to involve largely cell-bound PCMB. However, no complex formation between PCMB and calf thymus DNA is detectable spectrophotometrically. Sensitization of breaks is observable at concentrations above $6.3 \times 10^{-6}$ M, a concentration which is only minimally toxic to the cells, but sufficient to inhibit postirradiation DNA degradation and to produce the same sensitivity survival-wise in both strains. In contrast, no sensitizing effect in phase λ is observed. Possible mechanisms of action of PCMB are discussed. (auth)

**19895** RADIATION-INDUCED BINDING OF SOME PROTEIN AND NUCLEIC ACID CONSTITUENTS WITH MACROMOLECULAR COMPONENTS IN CELL SYSTEMS. Yamamoto, O. (Hiroshima Univ.). Radiat. Res.; 61: No. 2, 261-273(Feb 1975).

Radiation-induced binding yields of sulfur-containing amino acids, aromatic amino acids and nucleic acid bases with macromolecular substances in the cell lysates of Escherichia coli, in mammalian cell (L5178Y) lysates, and in intact cells of L5178Y were measured as a function of gamma dose. The binding yields of cysteine and cystine exceeded the yields of the others, both for cell lysates and for whole cells. The binding of these amino acids and bases with nucleic acid was observed only with intact cells. Binding ratios for cysteine with protein, nucleic acid and lipid in intact cell were 35, 20, and 45%, respectively, of the total binding. Sedimentation analysis showed that cysteine was bound mainly to protein and probably to lipid, and that RNA was cross-linked with other high molecular substances (mainly protein) by irradiation. (auth)

**19896** DNA STRAND BREAKS MEASURED WITHIN 100 MILLISECONDS OF IRRADIATION OF ESCHERICHIA COLI BY 4 MeV ELECTRONS. Johansen, I. (Univ. of Oslo); Brustad, T.; Rupp, W. D. Proc. Nat. Acad. Sci. U. S. A.; 72: No. 1, 167-171(Jan 1975).

A method was developed in which E. coli cells were irradiated with four MeV electrons and transferred to alkaline detergent within a fraction of a second. This technique minimizes the amount of repair of radiation damage before analysis without the necessity of using physical or chemical treatments to inhibit repair and alter the physiological condition of the cells. The yield of DNA strand breaks formed in covalent circular superhelical λ DNA molecules superinfecting E. coli lysogens was about 4-fold greater when the cells were irradiated in oxygen than when they were irradiated under nitrogen anoxia. The same yields were obtained in phosphate buffer at 3° and 22° as well as in growth medium at 37°, and the yields were not altered by the polA1 mutation. When E. coli lysogenic cells superinfected with λ were irradiated with doses sufficient to introduce at least seven breaks in the phage DNA, the chromosomal DNA and the superinfecting phage DNA sedimented similarly in alkaline sucrose gradients, indicating that both DNAs were broken to a similar extent during irradiation. However, the yield of breaks calculated for chromosomal DNA in similar experiments was greater than the yield calculated from the first break introduced into covalent circular λ DNA molecules. These apparently contradictory results are explicable either if the initial break in a superhelical molecule occurs with an efficiency different from that for subsequent breaks, or if the pulsed electron radiation produces a high proportion of double-strand breaks. (auth)

**19897** RADIOLOGICAL MAPPING OF THE RIBOSOMAL RNA TRANSCRIPTION UNIT IN E. COLI. Hackett, P. B.; Sauerbier, W. (Univ. of Colorado, Denver). Nature (London); 251: No. 5476, 639-641(18 Oct 1974).

The ribosomal RNA genes of E. coli are arranged in tandem behind a common promoter in the order 16S, 23S, and 5S. A redetermination of these positions on their unit of transcription is described using the uv light mapping technique, with a view to demonstrating the applicability of this technique to determination of the transcriptional linkage of genes in E. coli. The technique is based on the observation that certain lesions induced in DNA by uv light cause premature termination of transcription at the site of the lesion and that no re-initiation occurs beyond the lesion up to the next promoter. Synthesis of 23S rRNA was reduced more by uv light than was that of 16S rRNA, and synthesis of 5S rRNA was very sensitive to uv light. Dose-effect curves are shown and are discussed. 16S, 23S, and 5S rRNA could be positioned fairly accurately on p30, the precursor RNA containing the mature rRNA species, provided the inactivation coefficients and molecular weights of the rRNAs were known. The effect of photoreactivation is also discussed, including estimation of the fraction of the lesions that comprise pyrimidine dimers. The technique was regarded as more successful than the actinomycin D technique. (UK)

**19898** ISOLATION AND PROPERTIES OF A RECOMBINATION-DEFICIENT MUTANT OF MICROCOCCUS RADIODURANS. Moseley, B. E. B.; Copland, H. J. R. (Univ. of Edinburgh). J. Bacteriol.; 121: No. 2, 422-428(Feb 1975).

A mutant of Micrococcus radiodurans which is deficient in recombination has been isolated after treatment of the wild type with N-methyl-N'-nitro-N-nitrosoguanidine. We have called this mutant Micrococcus radiodurans rec30. The efficiency of recombination in this mutant, as measured by transformation, is less than 0.01% that of the wild type. It is 15 times more sensitive to the lethal action of ultraviolet radiation, 120 times more sensitive to ionizing radiation, and 300 times more sensitive to mitomycin C (MMC) than the wild type. It is probably inactivated by a single MMC-induced deoxyribonucleic acid cross-link per genome. The excision of ultraviolet-induced pyrimidine dimers is normal. There is no radiation-induced degradation of deoxyribonucleic acid. All spontaneous revertants selected for resistance to low levels of MMC had wild-type resistance to radiation and MMC, and the same efficiency of recombination as the wild type, suggesting that the recombination deficiency of the strain is due to a single mutation. Deoxyribonucleic acid from this mutant can transform M. radiodurans UV17 presumed deficient in an exr type gene to wild type. (auth)

**19899** ENZYMATIC PRODUCTION OF DEOXYRIBONUCLEIC ACID DOUBLE-STRAND BREAKS AFTER ULTRAVIOLET IRRADIATION OF ESCHERICHIA COLI K-12. Bonura, T.; Smith, K. C. (Stanford Univ., CA). J. Bacteriol.; 121: No. 2, 511-517 (Feb 1975).

Enzymatic production of deoxyribonucleic acid (DNA) double-strand breaks were observed in Escherichia coli K-12 after ultraviolet irradiation. Double-strand breaks appeared in wild-type, polA1, recB21, recA, and exrA strains after incubation in minimal medium. The uvrA6 strain showed no evidence of double-strand breakage under the same conditions. Data suggest that uvr$^+$ cells, which are proficient in the incision step of excision repair, accumulate double-strand breaks in their DNA as a result of the excision repair process, i.e., arising from closely matched incisions, excision gaps, or incisions and gaps on opposite strands of the DNA twin helix. Furthermore, strains deficient in excision repair subsequent to the incision step (i.e., polA, rec, exrA) showed more double-strand breaks than the wild-type strain. The results raise the possibility that a significant fraction of the lethal events in ultraviolet-irradiated, repair-proficient (uvr$^+$) cells may be enzymatically induced DNA double-strand breaks. (auth)

**19900** MARKER DISCRIMINATION IN DEOXYRIBONUCLEIC ACID-MEDIATED TRANSFORMATION OF VARIOUS PNEUMOCOCCUS STRAINS. Tiraby, G.; Fox, M. S.; Bernheimer, H. (Massachusetts Inst. of Tech., Cambridge). J. Bacteriol.; 121: No. 2, 608-618(Feb 1975).

The function responsible for discrimination among markers (point mutations) in Pneumococcus (hex) was traced back to the early strains used to demonstrate the chemical basis of transformation in the early 1940s. Those currently used laboratory strains failing to manifest this function arose from a single subline of the original strain. The function was also evident in other independently isolated strains including a number of different serological types. The hex function was not evident in transformation between heterologous pneumococcal strains probably as a result of the sensitivity of the function to saturation in the presence of deoxyribonucleic acid from closely related but nonisogenic strains. (auth)

**19901** ULTRAVIOLET LIGHT SENSITIVITY OF ESCHERICHIA COLI K-12 STRAINS CARRYING ruv MUTATIONS IN COMBINATION WITH uvrA OR lon MUTANT ALLELES. Iyehara, H.; Otsuji, N. (Kyushu Univ., Fukuoka). J. Bacteriol.; 121: No. 2, 735-736(Feb 1975).

Strains of Escherichia coli K-12 have been prepared that carry the ruv mutation in combination with lon or uvrA mutant alleles. The ruv$^-$ uvrA$^-$ double mutant is more sensitive to ultraviolet light than the uvrA$^-$ single mutant, whereas the strain with ruv and lon mutations shows the same sensitivity to ultraviolet light as the ruv$^-$ single mutant. (auth)

**19902** GENE-ENZYME RELATIONS OF TRYPTOPHAN MUTANTS IN STREPTOMYCES COELICOLOR A3(2). Smithers, C. M.; Engel, P. P. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Genetics; 78: No. 3, 799-808(Nov 1974).

Mutations in twenty-eight tryptophan mutants of S. coelicolor A3(2) were mapped relative to the nearest flanking markers. Mutants lacking single enzymatic activities for phosphoribosyltransferase, phosphoribosylanthranilate isomerase, indodeglycerol phosphate synthethase, tryptophan synthethase A, and tryptophan synthethase B were identified. (auth)

**19903** INDUCTION BY MUTAGENS OF TANDEM GENE DUPLICATIONS IN THE glyS REGION OF THE ESCHERICHIA COLI CHROMOSOME. Straus, D. S. (National Inst. of Environmental Health Sciences, Research Triangle Park, NC). Genetics; 78: No. 3, 823-830(Nov 1974).

Four mutagens (ultraviolet light, nitrous acid, the acridine half mustard ICR 372, and niridazole) were found to increase the frequency of tandem gene duplications in the glyS region of the Escherichia coli chromosome. This result was obtained by quantitating the spontaneous and mutagen-induced reversion frequency of a glycyl-tRNA synthetase (glyS) mutant. Following mutagenesis, as many as 0.2% of the survivors were observed to contain duplications in the glyS region. In addition, several classes of stable revertants of the glyS mutant were identified. (auth)

**19904** uv-INDUCED MUTAGENESIS IN RIBOSOME MUTATIONS OF ESCHERICHIA COLI. Oganesyan, M. G.; Chakhalyan, A. Kh. Biol. Zh. Arm.; 27: No. 8, 16-22(Aug 1974). (In Russian).

A comparative analysis was made of the frequency of spontaneous and uv-induced reversion to prototropism in two isogenic strains differing by the allele state of Str A locus, controlling the synthesis of one of the structural units of small subunits of ribosome and determining the relation of the culture to streptomycin. A difference was observed for both spontaneous and uv-induced leucine and arginine revertants. The frequency of occurrence of revertants of both types in the streptomycin-resistant strain was reduced in comparison with streptomycin-sensitive cultures. (tr-auth)

**19905** SENSITIZATION OF ULTRAVIOLET-IRRADIATED ESCHERICHIA COLI K-12 BY DIFFERENT AGARS: INHIBITION OF A REC AND EXR GENE-DEPENDENT BRANCH OF THE UVR GENE-DEPENDENT EXCISION-REPAIR PROCESS. Van der Schueren, E.; Youngs, D. A.; Smith, K. C. (Stanford Univ., CA). Photochem. Photobiol.; 20: No. 1, 9-13(Jul 1974).

E. coli K-12 wild-type cells plated immediately after uv irradiation had a much lower survival on minimal medium solidified with agar-agar No. 3 (Oxoid), purified agar (Difco) or ionagar (Colab) than on plates solidified with laboratory-washed Noble agar (Difco). An intermediate survival was obtained on plates solidified with unwashed Noble agar (Difco). When irradiated cells were incubated in liquid minimal medium for various times before subsequent plating on agar-agar No. 3, their survival increased rapidly and became identical to the survival of cells plated on washed Noble agar. The same phenomenon was found with polA 1 cells, but no differences in survival on the different agars were observed with uvrB, exrA, recA or recB cells. These data suggested that a repair process dependent on the uvrB, recA, recB and exrA (but not the polA) gene products was inhibited when UV irradiated E.coli K-12 cells were plated on minimal medium solidified with agar-agar No. 3, purified agar or ionagar. This implied that the uvr gene-dependent excision-repair process consisted of at least two branches, one controlled by the polA gene and a second controlled by the recA, recB and exrA genes and inhibitable by a substance present in certain agars. For maximum sensitivity, experiments designed to study chemical inhibitors of repair should use agar plates that do not themselves inhibit repair. (auth)

**19906** RELATIONSHIP BETWEEN SURVIVAL, PHOTOPRODUCT PRODUCTION, AND REPAIR CAPACITY IN A VARIANT OF BACILLUS CEREUS. Johnston, G. C.; Young, I. E. (York Univ., Toronto). Photochem. Photobiol.; 20: No. 3, 213-219(Sep 1974).

As sporulation progresses, there is an increased resistance to uv irradiation of the cells of Bacillus cereus var. alesti. This progressive increase was independent of post-irradiation treatment and appeared to be a property of the stage of sporulation. In addition, the proportion of photoproducts formed was different, for each stage of sporulation. Cells irradiated at Stage I (axial filament) of sporulation displayed relatively large amounts of spore photoproduct "c" and less of photoproduct "b". As sporulation proceeded, uv irradiation resulted in the production of more spore photoproduct "b" and less "c", suggesting a progressive change in configuration of the DNA within the sporulating cell. If irradiated early in the process (Stage II), large amounts of cyclobutane-type dimers were also produced which, with the "spore-specific" photoproducts, may be retained in the resultant spore. Although no excision-repair was detectable during germination of these spores, both vegetative and "spore-specific" damage was reduced during this period. The "spore-specific" repair mechanism may be able to remove vegetative damage from germinating spores. (auth)

**19907** THE STUDY OF VARIABILITY AND STRAIN SELECTION IN STREPTOMYCES ATROOLIVACEUS. I. UV Light and Nitrous Acid as Effective Agents in the Improvement of Mithramycin Production. Blumauerova, M.; Callieri, D. A. S.; Stajner, K.; Vanek, Z. (Ceskoslovenska Akademie Ved, Prague. Mikrobiologicky Ustav). Folia Microbiol. (Prague); 19: No. 2, 133-138(1974).

A seven-step selection procedure (repeated uv irradiation, single-step application of nitrous acid, and natural selection, following each mutagenic treatment) made it possible to increase production of mithramycin by Streptomyces atroolivaceus from 40 to 50 μg/ml to 680 to 830 μg/ml, i.e. roughly 15 to 19 times. The uv radiation was more effective in low doses, yielding about 5% survival; 2.3% survival was obtained after treatment with nitrous acid. N-methyl-N'-nitro-N-nitrosoguanidine applied in a buffer (pH = 9.0) at doses yielding more than 99% killing was less effective than the two former mutagens. (auth)

**19908** THE EXTENT OF PHENOTYPIC EXPRESSION OF UV-INDUCED STR-R AND STR-D MUTANTS IN ESCHERICHIA COLI B/R $THY^-TRP^-HCR^+$. Rauko, P.; Slamenova, D. (Slovenska Akademia Vied, Bratislava (Czechoslovakia). Vyskumny Ustav Onkologicky). Folia Microbiol. (Prague); 19: No. 2, 102-106(1974).

The effect of pre-irradiation cultivation on the extent of phenotypic expression of str-r and str-d mutants of Escherichia coli $B/r\ thy^-trp^-hcr^+$ during tryptophan and thymine starvation was investigated. UV light was used as a mutagenic factor. Pre-irradiation cultivation resulting in the inhibition of the total DNA synthesis essentially did not affect the frequency of str-r and str-d mutants. The extent of phenotypic expression increased for up to the second hour of cultivation; the maximum phenotypic expression only occurred 4 to 5 hrs after uv irradiation. (auth)

**19909** OBTAINING STREPTOCOCCUS LACTIS MUTANTS WITH AN INCREASED CAPABILITY OF PRODUCING NISIN. Hylmar, B.; Teply, M.; Tesarkova, H. Czech Patent 150096. 29 Sep 1972. 2p. (In Czech).

The manner of obtaining mutants with an increased capability of producing nisin from special, high-purity cultures of Streptococcus lactis is described. The method is based on the exposure of the microorganisms to gamma radiation at doses of 10,000 to 50,000 rads. Surviving individuals are cultivated and repeatedly irradiated by gamma and/or ultraviolet radiation. The resulting mutants are found to produce up to three times as much nisin than intact cultures. (INIS)

**19910** MICROBIOLOGICAL PURITY OF DRUGS AND EFFECT OF IONIZING RADIATION. Burianek, J. (Statni Ustav pro Kontrolu Leciv, Prague (Czechoslovakia)); Havlenova, V.; Synek, J. (Leciva, Narodni Podnik, Prague (Czechoslovakia)); Nemec, J. (Chirana, Narodni Podnik, Prague (Czechoslovakia)). Farm. Obz.; 43: No. 1, 19-28(1974). (In Czech).

The problems of possible microbiological contamination of pharmaceutical preparations are discussed, and laboratory model experiments aimed at verifying whether or not ionizing radiation can be applied in the decontamination of drugs are described. The experiments were carried out with Carbo medicinalis contaminated with Escherichia coli and Aerobacter strains. $^{60}Co$ gamma radiation was applied. The design and parameters of the irradiation device are described in more detail. (INIS)

**19911** STUDY OF THE EFFECT OF GAMMA-RAYS ON THE VIRULENT PROPERTIES OF EIMERIA TENELLA. Penev, P.; Stefanova, M. Vet. Sb.; 69: No. 11, 22-25(1972). (In Bulgarian).

The effects of different rates of gamma rays on the infective and virulent properties of E. tenella were studied. Two experiments were carried out with 76 chickens of the White Leghorn breed aged 10 to 12 days. Prior to experiments all chickens were kept under conditions that excluded any spontaneous infection of coccidia. The oocysts were subjected to gamma irradiation by means of a LMB-1M gamma source, the dose rate being 3574 r/min. Non-irradiated sporulated oocysts used as controls were stored under the same conditions as the irradiated ones. The first experiment was performed with 9 groups of chickens, each of 4 or 5 birds. All chickens in groups I to VII received orally 100,000 sporulated oocysts per head irradiated with a dose of 10,000, 20,000, 50,000, 100,000, 200,000, and 300,000 r. The same number of non-irradiated oocysts were given to the chickens in group VIII; group IX remained uninfected. Two weeks following the infection the chickens in all groups were challanged with 100,000 sporulated non-irradiated oocysts each. The second trial was conducted with 6 experimental groups each of 5 or 8 chickens; the birds in groups I to VI received 100,000 sporulated oocysts irradiated with doses of 5,000, 10,000, 15,000 and 20,000 r respectively; group V was infected with the same number of non-irradiated oocysts. The chickens in group VI were used as controls. It was found that gamma rays in a dose of 20,000 r and more disturb the sporulated oocysts and eliminate their infective and virulent properties. Rates of from 500 to 10,000 r did not interrupt the endogenous development of sporulated oocysts. Chickens inoculated with oocysts irradiated with these doses became resistant to a challenge with sporulated non-irradiated oocysts. This gives ground to use gamma-rays in producing specific immunoprophylactic means against coccidiosis in birds. (INIS)

**19912** EFFECT OF UV-LIGHT, CAFFEINE, AND NALIDIXIC ACID ON CELL DIVISION OF UV-SENSITIVE FILAMENT-FORMING MUTANTS OF SALMONELLA TYPHIMURIUM. Pokrovskii, V. N.; Guseva, O. A. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 10: No. 1, 123-139(Jan 1974). (In Russian).

Incubation of uv-sensitive filament-forming mutants of Salmonella after uv irradiation in a medium containing caffeine significantly decreased the number of viable bacteria. The survival of uv-irradiated cells in a buffer in the presence of caffeine was also sharply inhibited. The uv-sensitive filament-forming mutants were very sensitive to nalidixic acid. Treatment of the mutants with this acid resulted in intensive filament formation. Study of cell division in the filament-forming mutant P20 showed that filamentous cells formed after uv irradiation were able to divide and form microcolonies. The absence of differences in survival after uv irradiation in lysogenic and non-lysogenic bacteria is related to the fact that cell lysis precedes segregation of the viable clones. (tr-auth)

**19913** THE INFLUENCE OF RADIATION-INDUCED ELECTROLYTE SHIFT ON THE METABOLISM. P. 6. Investigations on Acetaldehyde Consuming Yeast. Rink, H. (Bonn Univ. (F. R. Germany). Abt. fuer Strahlenbiologie). Strahlentherapie; 148: No. 2, 186-194(Aug 1974). (In German).

The potassium-depending aldehyde dehydrogenase is inhibited by a surplus of acetaldehyde. Model experiments with acetaldehyde-consuming yeast cells under 3 different substrate concentrations in relation to the extracellular potassium-concentration prove a narrow connection and always corresponding change of potassium content and oxygen consumption. A radioinduced (200 kR) reduction of the potassium-content (about 15 μMol/per g) produces various effects on the oxygen consumption according to the degree of potassium activation by substrate inhibition. The results show that the metabolism is not only influenced by the loss of potassium, but also (and to a high extent) by the potassium activation of the reaction in question. (auth)

**19914** GAMMA RAY INDUCED MUTANTS IN RHIZOBIUM MELILOTI. Ali, A. M. M.; Younis, S. E. Y. (National Research Centre, Dokki, Egypt). Egypt. J. Genet. Cytol.; 4: No. 1, 131-136(Jan 1975).

The economic importance of Rhizobium is very attractive for studying its genetics. Biochemical mutants could be the most valuable differentiation to be used in genetical studies. This work was carried out to induce biochemical mutants, in Rhizobium meliloti of Trifolium alexandrinum, which are necessary for the genetical studies of this species. Samples were exposed to: 0, 1, 5, 10, 20, 40, 80, 120, 160, 200, 240, 280, and 320 krad γ rays. The results showed that there was stimulation in cell division for the doses 1 and 5 rads followed by a gradual reduction in the survivals. The lowest percentage of survivals obtained was that of 0.10 when exposed to 280 and 320 krads. More than one third of the mutants were tryptophane-requiring mutants, and more than one-fourth of them were arginine-requiring mutants. The number of the histidine-requiring mutants were similar to that of the arginine-requiring mutants. One mutant was adenine-requiring and another was methionine-requiring. (auth)

**19915** DARK REPAIR INHIBITORS AND PATHWAYS FOR REPAIR OF RADIATION DAMAGE IN SCHIZOSACCHAROMYCES POMBE. Nasim, A.; Smith, B. P. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Biology and Health Physics Div.). Mol. Gen. Genet.; 132: No. 1, 13-22(Aug 1974).

Different compounds known to inhibit dark repair in bacterial and mammalian systems have been tested for a similar effect in the yeast Schizosaccharomyces pombe. A marked inhibition of growth by these different drugs indicated that these were taken up by the cell, yet none except caffeine reduced the colony forming ability when present in the post-irradiation plating medium. The response of 22 different radiation sensitive mutants to the presence of caffeine in the plating medium was tested to investigate the probable number of pathways for repair of radiation damage in this organism. In some of the genetic crosses among single gene mutants showing a differential caffeine-response, supersensitive double mutants were obtained. Strains obtained either by additional crosses or by further mutagenic treatment of the supersensitive double mutants did not show a highly significant increase in radiation sensitivity. These observations indicate that the presently available radiation sensitive mutants represent defects in only two major pathways for repair of radiation damage in the wild type S. pombe. (auth)

# Radiation Effects on Plants

*Refer also to abstracts 19601, 19602, 19836, 19838, 20007, 21936, and 21937.*

**19916** (AEC-tr-7602, pp 7-14) INFLUENCE OF GAMMA IRRADIATION OF SEEDS ON CERTAIN PHYSICOCHEMICAL PROPERTIES OF THE HISTONES OF VICIA FABA AND TRIFOLIUM PRATENSE. Mal'tsev, A. V.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 480-485(1974).

In Radiobiology.

The irradiation of V. faba and Tr. pratense seeds at lethal doses induces progressive changes in the fractional composition of the histones of the seedlings, an increase in the electrophoretic mobility and content of SH groups. These indices are unchanged by irradiation at stimulating doses. In nonirradiated plants, during the growth of the seedlings, the ratio of the fractions of the histones varies. The level of sulfhydryl groups in the histones of the seedlings of the radioresistant Tr. pratense is higher at all the stages of growth studied than in the histones of the radiosensitive V. faba. (auth)

**19917** (AEC-tr-7602, pp 108-114) PECULIARITIES OF THE ACTION OF BIOLOGICALLY ACTIVE SUBSTANCES FORMED IN GAMMA-IRRADIATED POTATO TUBERS ON THE GERM CELLS OF ANIMALS. Kopylov, V. A.; Osipova, I. N.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 559-563(1974).

In Radiobiology.

It was shown that in the $\gamma$ irradiation of potato tubers at a dose of 10 kR, biologically active substances of the type of polyphenols and quinones are accumulated in them. Fractionation of extracts from the potato tubers yielded three fractions, arbitrarily called substances X and Z and the polyphenol fraction. X was isolated in crystalline form. It was noted that in the case of peroral administration of the enumerated fractions to male mice, substance X induces the formation of dominant lethal mutations at the first and fifth weeks of mating, substance Z at the third week, and the polyphenol fraction chiefly at the first week. Substance X and polyphenols are concentrated in the surface layer, while compound Z is distributed in the middle portion of the potato tuber. (auth)

**19918** (AEC-tr-7602, pp 202-206) INFLUENCE OF VARIOUS DOSES OF GAMMA IRRADIATION ON CERTAIN VARIETIES OF THE ALMOND. Imamaliev, G. N.; Brazhnikova, Zh. V. (Inst. of Genetics and Selection, Baku, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 625-628(1974).

In Radiobiology.

Air dried seeds were gamma-irradiated at doses of 0.5 to 50 kR. Survival and abnormalities of growth of seedlings were used as indices of radiosensitivity. With increasing doses the survival and growth of seedlings decreased while the percentage of morphological changes increased. Some of the changes were as follows: bifurcation of shoots, deformed leaf blades, coalescence of leaves, and reduction of size and thickness of leaves. Dwarfs and creeping forms were of interest from the economical standpoint. (HLW)

**19919** (AEC-tr-7602, pp 207-210) POSTRADIATION RECOVERY OF PLANTS WITH THE AID OF KINETIN. Filippova, N. F.; Kryukova, L. M. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 628-630(1974).

In Radiobiology.

Barley seedlings were given 100 to 2000 R x radiation and were placed in a solution of kinetin for 5 to 6 hrs. Extracts were prepared from leaves of broad bean plants or potato tubers irradiated at 25 kR; after exposure of barley seedlings to the extracts they were placed in a kinetin solution. The number of dividing cells in the meristem decreased with increasing radiation dose. Treatment with kinetin stimulated the intensity of cell division. Under influence of extracts from irradiated plants cell division was suppressed. (HLW)

**19920** (AEC-tr-7602, pp 211-215) RBE OF SECONDARY RADIATION FROM 70 GeV PROTONS AS A FUNCTION OF THE CRITERION OF ITS EVALUATION. Akoev, I. G.; Fomenko, B. S.; Akhmadieva, A. Kh.; Lebedev, V. N.; Lukanin, V. S. (Inst. of Biological Physics, Pushchino, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 631-634(1974).

In Radiobiology.

Air dried seeds of Vicia faba were subjected to irradiation on an accelerator with the gamma rays of $^{137}Cs$. Fifty anaphases were examined on each specimen and the number of bridges and fragments per cell counted. The RBE for each of the doses of accelerator radiation was determined according to the ratio of equieffective doses of secondary radiation and gamma radiation. The parameters of the dose curves of the yield of aberrations depended on the type of radiation and the period of fixation and the injurious action of the secondary accelerator radiation was higher in comparison with gamma radiation. (HLW)

**19921** X-RAY INDUCED ANEUPLOIDY IN CAPSICUM ANNUM. Subhash, K.; Nizam, J. (Osmania Univ., Hyderabad, India). Curr. Sci. (India); 44: No. 2, 62-63(20 Jan 1975).

Seeds of the red pepper, Capsicum annum, were soaked for 6 hrs and exposed to 4000 rads x radiation. Morphological variations were observed in the $F_1$ and $F_2$ generations, and an extra chromosome was observed in 90% of the $F_2$ pollen mother cells. All mutants were characterized by an increase in flower size, height, and yield. (HLW)

**19922** RADIATION EFFECTS ON THE SHOOT TIP CULTURE OF CHRYSANTHEMUM. Mabuchi, T.; Kuwada, H. (Kagawa Univ., Miki, Japan). Kagawa Daigaku Nogakubu Gakujutsu Hokoku; 25: No. 2, 171-177(Mar 1974). (In Japanese).

In order to make clear the effects of the radiation on meristem of embryo and growing point, which are sensitive to radiation in higher plants, as well as to induce the mutants, gamma-rays of 5, 10, and 20kR were administered to shoot tip cultures of chrysanthemum. The medium consists of Hyponex 1 g/l, thiamine 1 mg/l, kinetin 0.5 mg/l, agar 10 g/l, sucrose 30 g/l. Cultivars used were Kin-tenryu and Tenryu-no-asa at July and October respectively. The gamma rays were given at 3 and 5 days after planting on the medium in both cultivars. The number of survivals at 5 months after irradiation decreased in proportion to the increase of dosage in both cultivars. The shoot tips irradiated by gamma rays of 20 kR in both cultivars showed a tendency to callus formation. Three chlorophyll mutants have appeared showing chimeras; one of them was in the cultivar Kin-tenryu irradiated by gamma rays of 5 kR at 3 days after planting and two of them were in the cultivar Tenryu-no-asa irradiated by gamma rays of 20 kR at 3 days after planting. One mutant having the entire leaves has appeared at the cultivar Kin-tenryu irradiated by gamma rays of 20 kR at 5 days after planting. No relationship was found between the administration of gamma rays for the shoot tip culture and the morphogenesis. The phenomenon of shoot multiplication from one shoot tip has been observed following the irradiation. (auth)

**19923** DEPENDENCE OF REPAIR EFFECT OF EXOGENOUS DNA ON TIME-INTERVAL OF ITS APPLICATION TO IRRADIATED CELLS. Slotova, J.; Karpfel, Z. (Inst. of Biophysics, Brno). Stud. Biophys.; 44: No. 3, 191-196(1974).

The effect of genetically differing DNAs on the course of their postirradiation repair dependent on the time interval between the application and irradiation was studied in the meristematic cells of Vicia faba primary roots. Exogenous DNA of various origin was applied to the roots at 20, 4, 1 hr. intervals and at 10 min. interval before and after irradiation with 170 R exposure. In the course of the repair, mitotic activity of the cell population studied was evaluated and frequency of postmetaphase chromosomal aberrations was recorded. In contrast to xenogeneic DNA, in all the cases the syngeneic DNA increased mitotic activity of the irradiated cells. The effect of exogenous DNA was found to be lower and exhibiting no direct dependence on duration of the time interval between the application and irradiation of the DNA. The frequency of chromosomal aberrations induced by radiation was decreased only with the syngeneic DNA with no respect to the time interval of the application. However, with the xenogeneic DNA, the postirradiation incidence of aberrations was increased in all the intervals. (auth)

**19924** EFFECT OF RADIATION ON TOMATO SEEDS AND SEEDLINGS. Tumanyan, E. R. (Erevan State Univ.). Biol. Zh. Arm.; 27: No. 8, 65-73(Aug 1974). (In Russian).

The effect of different doses of x radiation (1, 2, 5, 7, 10, 20, and 25 kR for seed and 0.2, 0.5, 1, 2, and 5 kR for seedlings) was studied. The doses stimulating and inhibiting growth and development of the tomato seedlings were determined. The data from field tests agreed with laboratory data. (tr-auth)

**19925** MODIFICATIONS AND MUTATIONS INDUCED BY THERMAL NEUTRONS IN BARLEY. Dotlacil, L. (Institute of Genetics and Plant Breeding, Prague-Ruzyne (Czechoslovakia)); Uhlik, J. (Vysoka Skola Zemedelska, Prague (Czechoslovakia)). Genet. Slechteni; 10: No. 1, 1-8(Jan 1974). (In Czech).

The effect of thermal neutrons in doses between $1 \times 10^{12}$ and $3 \times 10^{13}$ n cm$^{-2}$ was investigated on the barley cultivar "Diamant". Irradiation with doses of 1.5 to $2.5 \times 10^{13}$ n cm$^{-2}$ induced a noticeable delay in development. On the 14th day and the 47th days after drilling, $LD_{50}$ doses varied between 2.75 and $3 \times 10^{13}$ n cm$^{-2}$ and between 1.75 and $2.5 \times 10^{13}$ n cm$^{-2}$, respectively. The grain yield of irradiated plants decreased linearly with increasing dose. Irradiation with a dose of $1.75 \times 10^{13}$ n cm$^{-2}$

resulted in the yield of caryopses not exceeding 50% of that in the controls. The application of medium and higher doses resulted in an increased number of spikelets per plant as well as in an increased total number of tillers. The proportion of fertile spikelets in the total number of spikelets as well as the average weight of grains per plant and per head decreased with increasing doses. The average weight of grains, however, did not drop below 50% as against the controls. The proportion of sterile heads increased considerably. The variability of investigated characteristics increased with increasing dose. Depending on the dose, the sprouting of plants in generation $M_2$ decreased, not, however, below 89.5% as against the controls. Most segregating progenies (21.6%) and chlorophyll mutants (4.5 mutants per 100 plants of the $M_2$ generation and 0.67 mutants per one progeny) were induced by a dose of $3 \times 10^{13}$ n cm$^{-2}$. Doses approaching 1.5 to $2 \times 10^{13}$ n cm$^{-2}$, however, can be recommended for breeding purposes. (auth)

**19926** RADIOBIOLOGIIA I GENETIKA ARABIDOPSISA. (Radiobiology and Genetics of the Arabidopsis Plant). Ivanov, V. I. Moscow; Izdatel'stvo Nauka (1974). 192p.

The arabiodopsis plant is a promising object of investigation in the fields of radiobiology, genetics, and space biology. The present work describes the main characteristics of this plant, its growth, and its laboratory study. Methods for genetic crossing are described, taking into account the main types of mutation: morphological, chlorophyllic, and cytoplasmic. A procedure is outlined for establishing a correlation between recorded indices of an induced mutation process and the number of mutations arising in the cells of the embryonic meristem. The somatic and genetic effects of gamma irradiation of the seeds and irradiation by 2 and 5.6 MeV neutrons are investigated, as well as the effects of post-radiation storage and thermal shock. (IAA)

**19927** EFFECT OF GIBBERELLIC ACID ON ALPHA AMYLASE ACTIVITY OF MUTAGEN-TREATED BARLEY SEEDS. Paliwal, K. K.; Prasad, B.; Kumar, S. (Regional Station of Agricultural Research, Sumerpur, India). Curr. Sci. (India); 44: No. 3, 86-87(5 Feb 1975).

The activity of alpha amylase was determined in barley seeds following treatment with gamma radiation, EMS, and MMS. The seeds were then treated with gibberellic acid. The enzyme activity of the irradiated seeds increased, but decreased with increased radiation doses. The mutagens EMS and MMS caused a reduction in enzyme activity; following treatment with gibberellic acid the enzyme activity increased. (HLW)

**19928** INDUCED MAIZE MUTATIONS. Stoilov, M.; Toseva, R. (Akademiya na Selskostopanskite Nauki, Sofia (Bulgaria)). pp 161-174 of Scientific Session of the Institute of Genetics and Plant Breeding–Sofia, 15th and 16th March 1971. Sofia; Izdatelstvo na Bylgarska Akademiya na Naukite (1973). (In Bulgarian).

From scientific session of the Institute of Genetics and Plant Breeding; Sofia, Bulgaria (15 Mar 1971).

Data are reported on the frequency and the spectrum of maize mutations induced by gamma and fast-neutron irradiation of seeds and pollen. The following doses were used for the seeds: 5.0, 8.0, 12.0 and 20.0 krad of gamma rays and 600, 1000 and 1500 rad fast neutrons, whereas 1000 rad gamma rays were applied to the pollen. A great difference was established between the individual varieties and hybrids with respect to the spectra and frequencies of the induced mutations. A higher percentage of mutations was induced if fast neutrons were used, whereas a richer spectrum of the mutations, if irradiation with gamma rays was applied. Several valuable mutations were obtained: male sterile, early, multicob, dwarf, and other forms, which may be successfully used in maize breeding. The percentage of useful mutations ranges from 0.15 to 2.11. The induced male-sterile lines possess a Noldovian and Texan types of sterility, respectively. It is possible that by pollen irradiation, the nuclear factors determining the restoration of fertility could mutate. Lines of a highth combining ability were established. Their percentage ranges from 0.01 to 0.91. A hybrid, obtained from the lines Ruse 9 and Madan, gave a very high yield, excelling the yield of the high-yielding simple $SK_4$ hybrid by 18%. (auth)

**19929** RADIATION SENSITIVITY OF FLAX. Filev, K.; Mazadzhieva, L. pp 635-639 of Vtora Natsionalna Konferentsiya po Botanika. Sofia; Bylgarska Akademiya na Naukite (1973). (In Bulgarian).

From 2nd national conference on botany; Sofia, Bulgaria (13 Oct 1969).

The effect of gamma radiation on growth and development of four varieties of flax (Plovdiv 242, Svetoch, No. 1288, and Viera) was studied. The seeds were irradiated with the GUBE-4000 source in doses of 5, 10, 15, 20, and 25 kR at rates of 45 to 180 and 1720 R1 min. Under laboratory conditions, the length of the first leaf was measured after 7 days of growth. In field experiments measurements were made at different phases of growth. The results showed that the radiobiological effect of all doses tested changed as a function of the dose rate. The effect of the rate was apparent not only in the initial stages of development but also during the vegetative period. The optimum stimulating dose was 10 kR, but both dose rates had a stimulating effect. (tr-auth)

**19930** INVESTIGATIONS ON THE RADIO-SENSITIVITY OF SALVIA SCLAREA L. Ilieva, S.; Mekhandzhiev, A. (Akademiya na Selskostopanskite Nauki, Sofia). pp 229-238 of Scientific Session of the Institute of Genetics and Plant Breeding. Sofia; Izdatelstvo na Bylgarska Akademiya na Naukite (1973). (In Bulgarian).

From scientific session of the Institute of Genetics and Plant Breeding; Sofia, Bulgaria (15 Mar 1971).

Studies were carried out on the radiosensitivity of Salvia sclarea to gamma and neutron radiation. In the case of irradiation with 1 krad gamma rays and 100 rad of fast neutrons, a stimulation effect is manifested, expressed in a higher percentage of germination and survival rates, in a more intensive growth of roots and the stem and in a higher percentage of seed in the plants. In relation to the survival rate, if plants are irradiated with fast neutrons, almost as many plants survive as germinate, whereas in the case of gamma-irradiation, after a maximal percentage is reached there occurs an intensive period of perishing of the plants. The radiation depression is manifested in a different manner in the two ways of irradiation. If fast neutrons are used, it is more strongly expressed in the growth of the stem, while in the case of gamma-ray irradiation, in the growth of the roots. The critical dose in gamma-irradiation varies from 10 and 11 krad. (auth)

**19931** EFFECT OF UV- AND GAMMA-RAY IRRADIATION OF POLLEN ON THE MANIFESTATION OF THE HETEROSIS EFFECT ON $F_\alpha$ TOMATOES. Daskalov, C.; Moynova, K.; Popova-Konstantinova, M. (Akademiya na Selskostopanskite Nauki, Sofia). pp 5-14 of Scientific Session of the Institute of Genetics and Plant Breeding. Sofia; Izdatelstvo na Bylgarska Akademiya na Naukite (1973). (In Bulgarian).

From scientific session of the Institute of Genetics and Plant Breeding; Sofia, Bulgaria (15 Mar 1971).

The following conclusions may be drawn from the experiments on the effect of pollen irradiated with uv and $\gamma$ rays on the manifestations of a heterosis effect in $F_1$ tomatoes. Irradiation of tomato pollen with uv rays for 15 minutes and $\gamma$ rays 800 R stimulates germination and enhances the activity of polyphenoloxidase. Buds of the mother's variety, pollinated with pollen, irradiated with uv and $\gamma$ rays, analyzed after a 48-hour period, manifest a higher polyphenoloxidase activity in comparison with the control ones. Seeds, obtained by the use of pollen irradiated with uv rays germinate more quickly and have a higher percentage of germination. Seeds, obtained from pollen irradiated with $\gamma$ rays germinate more slowly in the beginning, but after that they show the highest percentage of germination which is very quick and simultaneous. The height of $F_1$ plants, obtained from irradiated pollen, is greater. The flowering of $F_1$ plants, grown from pollen treated with uv- and $\gamma$-rays, starts earlier and ends in a shorter period of time. The data from investigations carried out so far indicated that the manifestation of the heterosis effect in tomatoes at the early growth stages of the $F_1$ progenies in favorably affected by the treated pollen which has been stimulated by means of these irradiations. This fact shows the heterosis effect in $F_1$ is influenced by the pollen which the mother variety is pollinated. Investigations in $F_1$ on the index of earliness, the relative total yield and the number of fruit are continuing. (auth)

**19932** RESULTS FROM IRRADIATION OF CERTAIN WHEAT HYBRID COMBINATIONS. Savov, P. (Akademiya na Selskostopanskite Nauki, Sofia). pp 175-183 of Scientific Session of the Institute of Genetics and Plant Breeding. Sofia; Izdatelstvo na Bylgarska Akademiya na Naukite (1973). (In Bulgarian).

From scientific session of the Institute of Genetics and Plant Breeding; Sofia, Bulgaria (15 Mar 1971).

Forms with valuable biological and commercial properties, were obtained as a result of irradiation of hybrid material. The irradiation was carried out with doses of 5 and 10 kR. The new forms possess a high resistance to loading, which in addition to lower stems, is also the result of their greater thickness. The relatively lower and very stout stems are also very leafy. Leaves have a considerably larger surface than these of the Bezostaya-1 variety. This secures a wider surface for photosynthesis to the plants. The number of grains in some of the forms ranges from 68 to 76 per year. Likewise, they possess a group resistance to rusts and powdery mildew. This resistance is manifested both in the open and in laboratories. The results obtained give grounds to consider that the combination of hybridization technique with that of induced mutagenesis could lead to an extension of the form-building process in certain cases. In this case material, valuable to breeding, could be obtained. (auth)

**19933** EFFECT OF $^{60}$Co GAMMA RAYS, 600-MeV PROTONS, AND 14- AND 400-MeV NEUTRONS ON THE PRINCIPAL ROOT OF VICIA FABA. Laurent, J. M. Geneva; European Organization for Nuclear Research (1974). 122p. (In French). (CERN-74-25).

This report describes a series of experiments carried out at CERN, at the Geneva Hospital, and at CEN Grenoble, to determine the effect of gamma rays, neutrons, and protons of high energies on the growth rate of Vicia faba bean roots. A model is described for predicting the growth rate of Vicia faba, from which can be calculated the survival fraction of cells at doses that may be expected in radiation accidents. The models for cell survival presented by Chadwick and by Lea are discussed, and it is shown that the relative biological effectiveness of 600 MeV proton beams, and 14 and 400 MeV neutron beams can be computed. (auth)

**19934** NEW EARLY MATURING TYPE OF JUTE MUTANT. Chatterjee, A.; Jana, A. K. (Jute Agricultural Research Inst., Barrackpore, India). Sci. Cult. (Calcutta); 40: No. 7, 319-320 (Jul 1974).

Seedlings of Corchorus capsularis were exposed to gamma radiation from the age of two months until flowering. Seeds of these plants were collected and sown and the seedlings that developed were exposed to radiation. In the third generation plants flowered within 30 days in contrast to the normal 100-day flowering time. These early mutants were short in stature. Advantages of early-flowering mutants are pointed out. (HLW)

**19935** EFFECT OF IONIZING RADIATION ON SEED GERMINATION OF PASSIFLORA SPECIES. Torne, S. G.; Raut Desai, N. P. (Chogule Coll., Margao, India). Curr. Sci. (India); 44: No. 4, 112-113(20 Feb 1975).

The effects of various doses of $\gamma$ rays on seed germination of Passiflora species were determined. Seeds of P. edulis and P. foetida were exposed to $\gamma$ rays at doses ranging from 1 kR to 30 kR. It was found that low doses (1 to 2.5 kR) increased both the % germination and survival of the seeds. Doses in this same range also accelerated seed germination by 8 days in P. edulis and 5 days in P. foetida. (ERB)

# Radiation Effects on Animals

## Man

*Refer also to abstracts 19553, 19554, 19561, 19563, 19570, 19571–19574, 19860, 19878, 20130, 20150, 21278, 21284, 21289, 21799, 21883, 21887, 21893, and 21900.*

**19936** (CONF-731005-, pp 428-442) ON THE CHARACTERIZATION OF THE HUMAN CLONOGENIC CANCER CELL. I. Its Number and Its Radiosensitivity. Andrews, J. R. (Georgetown Univ. Medical Center, Washington, DC). 1975.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

In cell cycle in malignancy and immunity.

Fundamental to an understanding of the cell cycle and, especially, its implications in cancer is a consideration of the number of cells with unlimited proliferative, that is, clonogenic, capacity and their radiosensitivity. There is no direct method for the quantification of these parameters in human cancers. Human cancer radiotherapy does provide an indirect solution, for such radiotherapy data may be treated in a manner similar to the treatment of in vitro or in vivo radiation dose–cell survival data. That is, the fraction of human cancers not cured or the fraction recurring may be treated as the "surviving fraction" and a dose–response relationship developed. Such a curve permits the assessment of radiosensitivity as a function of $D_0$ and the extrapolation of the curve to zero dose yields a number $N_0n$, $N_0$ being an approximation of the number of clonogenic cells and n being their mean extrapolation number. Several reported clinical series of squamous- and basal-cell cancers and of Hodgkin's disease are suitable for such treatment. Their analysis suggests $D_0$'s of 200 to 400 rads and $N_0n$'s of several hundred to several tens of thousands for squamous- and basal-cell carcinomas and a $D_0$ of 150 rads and an $N_0n$ of 150,000 for Hodgkin's disease. The implications of these findings are developed. (auth)

**19937** [(CONF-740960-5) INITIAL SHAPE OF CELL SURVIVAL CURVES: A SUMMARY AND REVIEW OF THE 6th L. H. GRAY CONFERENCE. Elkind, M. M. (Argonne National Lab., Ill. (USA)). 1974. Contract W-31-109-Eng-38. 47p. Dep. NTIS $5.50.

From 6th L. H. Gray conference on initial shapes of cell survival curves; clinical and theoretical implications; London, UK (16 Sep 1974).

The treatment of cancer with radiation (and some of the epidemiological effects of radiation) can be strongly dependent on the initial slope of the cell survival curve(s) involved. When dose fractionation is used, this dependence is evident in the shape of the isosurvival curve; that is, the total dose to produce a given effect as a function of the number of fractions used. A nonzero initial slope implies that the total dose will increase to a maximum and hence, once this is reached, the total dose becomes independent of the number of dose fractions. Starting with direct measurements with various types of (primarily) mammalian cells, and covering a gamut of observations including fractionation studies with animal tumors and human skin, the evidence supporting nonzero initial slopes on survival curves was examined. The inferences following therefrom for cellular mechanisms of inactivation, and the implications of a nonzero initial slope on the survival curve in fractionation radiation therapy both in respect to normal tissue damage and tumor sterilization are discussed. While for cells the burden of the evidence did not clearly support a particular survival expression, neither qualitatively nor quantitatively, and while for tissues causes other than a nonzero initial slope were identified as able to produce a plateau in the isosurvival curve, a number of positive contributions to the understanding of damage-repair processes in cells and how these relate to the radiation therapy of cancer are presented. (CH)

**19938** (DHEW/FDA–75-8010, pp 32-36) BRH ACTIVITIES TO MEET ITS CHALLENGES. Villforth, J. C. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The challenge of the changing philosophy of radiation protection is discussed in relation to the increase in consumer awareness of the problems. Examples cited are the development of standards for diagnostic x-ray equipment used in the USA and a proposed study of patient exposure to radiation during diagnostic uses of radioisotopes in nuclear medicine. The role of the Bureau of Radiological Health in the radiation protection of patients and the general population is discussed. (CH)

**19939** (DHEW/FDA–75-8010, pp 37-40) RECENT FIELD INITIATIVES OF FDA. Ottes, R. T. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Activities of the Food and Drug Administration in the field of radiation protection are reviewed. Radiation control officers were assigned to each of the 10 regional offices to work on compliance with the standards for diagnostic x-ray equipment. Seminars were held for repairmen to inform them of their responsibilities in maintaining equipment in compliance with the standards. Tests were also conducted on some radiopharmaceuticals, analyses were made of radionuclides in foods, and microwave ovens and color television sets were tested for radiation emission. The active role of the Food and Drug Administration in information exchange, education, and training related to radiation protection of the general public is stressed. (CH)

**19940** (DHEW/FDA–75-8010, pp 41-44) OVERVIEW OF EPA'S RADIATION PROGRAM. Rowe, W. D. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Programs of the US Environmental Protection Agency relevant to the radiation protection of the general public and personnel are briefly summarized. Topics discussed include the development of standards for the uranium fuel cycle, monitoring radionuclides in drinking water, medical exposure to x radiation, radiation hazards from abandoned uranium mines, and the review of waste management problems. (CH)

**19941** (DHEW/FDA–75-8010, pp 51-55) REPORT OF THE TASK FORCE ON NATIONWIDE EVALUATION OF X-RAY TRENDS. Fisher, E. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Progress is reported in the development of regulations aimed at the radiation protection of patients during diagnostic radiographic exposure to x radiation. (CH)

**19942** (DHEW/FDA–75-8010, pp 63-65) REPORT OF THE TASK FORCE ON MODEL REGULATIONS, PART F. Dolezal, A. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The cooperation of Federal and State agencies in programs for the radiation protection of t' e general population is discussed. A model of State Regulations is reviewed. (CH)

**19943** (DHEW/FDA-75-8010, pp 67-72) REPORT OF THE TASK FORCE ON PERSONNEL DOSIMETRY. Lloyd, L. L. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Recommendations for personnel radiation dosimetry are presented. The need for a continuing performance testing program for pers nnel dosimeters is stressed. (CH)

**19944** (DHEW/FDA-75-8010, pp 89-93) NATIONAL ANALYSIS OF THE ORGAN DOSE INDEX SYSTEM. Bunge, R. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

A program (NEXT) for the national analysis of diagnostic x-ray procedures to determine optimum exposure ranges with the aim of reducing the radiation dose to patients and personnel during medical and dental examinations is discussed. The role of the Bureau of Radiological Health in support of the program is emphasized. (CH)

**19945** (DHEW/FDA-75-8010, pp 94-102) PUTTING NEXT DATA TO WORK IN KENTUCKY. Flater, D. A. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Data obtained during an analysis of diagnostic x-ray procedures (NEXT program) in Kentucky are reviewed in relation to relevance to recommendations leading to reduction of the radiation dose to personnel and patients. (CH)

**19946** (DHEW/FDA-75-8010, pp 103-107) STATUS AND EFFECT OF X-RAY EQUIPMENT STANDARDS. Britain, R. G. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Amendments to the performance standards for diagnostic x-ray equipment effective August 1, 1974, are reviewed and the effectiveness of the standards is discussed. It is concluded that not only will the standard have a beneficial effect on the radiation safety features of x-ray equipment, but it will also have a beneficial effect on the quality of the diagnostic product. (CH)

**19947** (DHEW/FDA-75-8010, pp 108-117) BRH EFFORTS IN THE ANALYSIS OF X-RAY IMAGE RECEPTOR PERFORMANCE. Schneider, R. H. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The relationship between the characteristics of the image receptor system and the diagnostic performance of medical x-ray equipment is discussed. The possibility of regulation of image receptor systems by performance standards under the Radiation Control for Health and Safety Act is suggested. (CH)

**19948** (DHEW/FDA-75-8010, pp 118-137) WHERE DOES THE PROBLEM LIE? Villforth, J. C.; Cole, W. S.; Alcox, R. W.; Trout, E. D.; Brunner, P.; Gilbert, R. L. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Factors to be considered in the quality control of diagnostic x-ray examinations are discussed. It is concluded that it is important to select the technique that will give the most information about the condition of the patient. The unnecessary use of diagnostic x-rays for various reasons is also discussed. (CH)

**19949** (KFK-2062) TOPOGRAPHY WITH NEGATIVE PIONS BY OBSERVATION OF GAMMAS FROM THE $\pi^0$ DECAY AFTER THE CHARGE EXCHANGE REACTION $\pi^- p \rightarrow \pi^0 n$. Bueche, G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Experimentelle Kernphysik). Oct 1974. 47p. (In German). Dep. NTIS (US Sales Only) $5.50.

It is shown that the gamma quanta from the $\pi^0$ decay after the charge exchange reaction $\pi^- p \rightarrow n\pi^0$ can be used to map the capture region of a $\pi^-$ beam in hydrogenous substances. In view of the applications in radiotherapy, the detectors have to be placed laterally from the absorber volume. For such a geometry the probability distribution of $\gamma$-$\gamma$-coincidences have been calculated. The results show that the range of the beam and its lateral position can be determined to the order of one millimeter within a time short compared with irradiation times usual in radiotherapy. (auth)

**19950** (STI/PUB-368) ADVANCES IN CHEMICAL RADIOSENSITIZATION. Panel Proceedings Series. Conference Held in Stockholm, Sweden, June 25-29, 1973. (International Atomic Energy Agency, Vienna (Austria)). Aug 1974. 160p. (CONF-7306110-). IAEA $8.00.

Separate abstracts were prepared for the 12 papers presented at the conference. (HLW)

*For abstracts of individual papers see: 19846, 19847, 19860-19863, 19889-19892, 19954, and 20047.*

**19951** (STI/PUB-375) POPULATION DOSE EVALUATION AND STANDARDS FOR MAN AND HIS ENVIRONMENT. Proceedings Series. Proceedings of the Seminar Held in Portoroz, Yugoslavia, May 20-24, 1974. (International Atomic Energy Agency, Vienna (Austria)). Sep 1974. 657p. (In several languages). (CONF-740529-). IAEA $31.00.

Separate abstracts were prepared for the 45 papers presented at the conference. (HLW)

*For abstracts of individual papers see: 19552-19555, 19570-19575, 19582, 19590-19592, 19604, 19605, 19970-19988, 20077-20083, 21289, 21799 and 21883.*

**19952** (SZS-153, pp 234-238) ORGANIZATIONAL PRINCIPLES OF PERSONNEL MONITORING. Schamov, B. P.; Liberman, A. 1974. (In Russian).

In report of the National Centre for Radiation Protection of the GDR.

The general principles of the personnel monitoring system for occupational exposure with x- and gamma radiation in USSR are dealt with. To establish uniformly extent and counts of personnel monitoring the authors propose a classification of radiation sources according to the radiation hazard of personnel. The most important of radiation work is classified as proposed and the resulting conclusion for personnel monitoring is discussed. (INIS)

**19953** THE NATURAL RADIATION DOSE TO MAN. Gans, I. (Bundesgesundheitsamt, Berlin (F. R. Germany). Inst. fuer Wasser-, Boden- und Lufthygiene). At. Inform.; No. 9, 5-6(1973). (In German).

On the subject of the natural radiation dose to man discussed at a symposium held on July 18, 1973 in Frankfurt under the sponsorship of the German X-ray Society (Deutsche Roentgengesellschaft), a review is given on the problem of the natural radiation burden to man, the radiation risks involved, especially regarding their influencing mankind in modern civilization, and the significance of radiation protection problems in the economic use of nuclear energy. (GE)

**19954** CLINICAL EXPERIENCE WITH COMBINED RADIOCHEMOTHERAPY OF MALIGNANT TUMORS. Rode, I. L. (National Oncological Inst., Budapest). pp 143-145 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Surgical intervention, irradiation or chemotherapy applied individually in the therapy of malignant diseases resulted in no definite improvement. The insufficient responses prompted clinicians to perform trials of surgical intervention combined with radiotherapy. Developments achieved in chemotherapy, however, lead to the application of surgical intervention combined with chemotherapy and also radiotherapy combined with chemotherapy. Recent results of extensive cytological and molecular biological studies furnished a scientific basis for the application of radiotherapy combined with chemotherapy. The present report deals with 529 cases treated from January 1968 to December 1972. According to the localization of their primary tumors the patients treated were distributed into eight groups: brain; head and neck; chest (breast); stomach; abdomen; sarcomas (osteogenic and soft tissue); malignant lymphomas; and leukaemia. Out of these

cases brain, oral cavity, breast, and leukaemic children patients are reported in this paper. The rational synchronization of the irradiation and drug application still requires an extensive and very comprehensive theoretical and practical study. (auth)

**19955** CONSERVATIVE TREATMENTS OF BREAST CANCERS. International Symposium, Strasbourg, France, June 1972. Paris; Masson et Cie (1974). 433p. (In French and English). (CONF-7206107-; ISBN-2-225-38445-2).

Separate abstracts were prepared for two of the 52 papers included that discuss problems related to the diagnosis and treatment of breast neoplasms. (CH)

*For abstracts of individual papers see: 19956 and 19957.*

**19956** DOSIMETRIC STUDY OF RADIUM THERAPY OF BREAST CANCERS. Wambersie, A.; Maisin, H.; Dardenne, J. C. (Institut du Cancer, Louvain, Belg.). pp 171-186 of Conservative Treatments of Breast Cancers. Paris; Masson et Cie (1974). (In French).

From international symposium on conservative treatments of breast cancers; Strasbourg, France (Jun 1972). See CONF-7206107-.

A study was made of the radiation dose distribution and dose rate in the mammary gland following the insertion of radium needles for therapy following initial treatment of neoplasms with a $^{60}Co$ $\gamma$ beam. The irradiation procedure used is described. (CH)

**19957** ATTEMPT AT DOSIMETRY IN THE TREATMENT OF BREAST CANCERS BY RADIOTHERAPY ALONE. Creteil Technique. Danczak, J.; Marinello, G.; Pierquin, B. pp 187-189 of Conservative Treatments of Breast Cancers. Paris; Masson et Cie (1974). (In French).

From international symposium on conservative treatments of breast cancers; Strasbourg, France (Jun 1972). See CONF-7206107-.

Attempts were made to measure the radiation dose distribution in the mammary gland during radiotherapy of neoplasms using combined external irradiation with a $^{60}Co$ $\gamma$ beam and internal irradiation using $^{192}Ir$ radiation source implants. Isodose curves were prepared for the irradiation technique described. (CH)

**19958** IRRADIATION IN PREVENTING GYNECOMASTIA INDUCED BY ESTROGENS. Brown, J. S.; Rubenfeld, S. (New York Univ., NY). Urology (Ridgewood, N. J.); 3: No. 1, 51-53 (Jan 1974).

Symptomatic breast changes usually accompany endocrine therapy for prostatic cancer. Thirteen patients with cancer of the prostate were given external irradiation to their breasts prior to initiation of estrogen therapy in the hope that undesirable changes in the breast would not occur. Results were satisfactory. (auth)

**19959** HEMORRHAGIC RADIATION CYSTITIS: TREATMENT. McGuire, E. J.; Weiss, R. M.; Schiff, M. Jr.; Lytton, B. (Yale Univ., New Haven). Urology (Ridgewood, N. J.); 3: No. 2, 204-208 (Feb 1974).

Intractable bladder hemorrhage may be a late result of pelvic irradiation. The bleeding may be life-threatening, particularly in patients unsuited for cystectomy. Experience with nonextirpative treatment including formalin instillation and the Helmstein hydrostatic pressure balloon technique is presented. These procedures provide worthwhile alternative methods to surgery. (auth)

**19960** CROSS-SECTIONAL ABSORPTION DENSITY RECONSTRUCTION FOR TREATMENT PLANNING. Friedman, M. L.; Beattie, J. W.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Phys. Med. Biol.; 19: No. 6, 819-830(Nov 1974).

Spatial absorption density distributions were reconstructed from simulated sequential transmission scans at multiple angles utilizing computer approximation techniques. A quantitative measure of the relative variance of the reconstructed density map was obtained, and the component due to Poisson statistics was shown to be in agreement with a theoretically derived function. (auth)

**19961** COMBINED HYPERTHERMIA AND RADIATION SUGGEST AN ALTERNATIVE TO HEAVY PARTICLE THERAPY FOR REDUCED OXYGEN ENHANCEMENT RATIOS. Robinson, J. E.; Wizenberg, M. J.; McCready, W. A. (Univ. of Maryland, Baltimore). Nature (London); 251: No. 5475, 521-522(11 Oct 1974).

Cells that are poorly oxygenated when irradiated are more resistant to conventional x-irradiation than those that are well oxygenated. Many types of tumours are hypoxic and thus may be more resistant to radiation than the well-oxygenated surrounding normal tissue, and much effort has been expended in attempts to circumvent this problem. Attention is now focused on the use of heavy particles, and data were obtained suggesting that hyperthermia in conjunction with megavolt radiation may circumvent the oxygen problem. The radiation sensitivity of some mammary tumors in mice was increased by a factor of 4.27 by treatment at 43°C, while that of normal mouse skin was increased by a much smaller factor. These tumors are considered to be poorly oxygenated, and the data obtained suggest a considerable differential effect of hyperthermal treatment on the radiation sensitivity of hypoxic and well oxygenated cells. The radiation dose used was 800 R, at 100 R/min., and full experimental details are given. The hyperthermal treatment was induced by flowing $N_2$ containing 5% $CO_2$ over the cell surpression, and the degree of hypoxia was considered adequate when <10 ppm $O_2$ was detected. For the oxygenated cells air replaced the $N_2$. Some representative recently reported oxygen enhancement ratio values are listed from studies with accelerator heavy particle beams. The production of thermal fields necessary for the treatment of patients will require considerable research and engineering. If suitable thermal fields can be achieved the use of hyperthermia in conjunction with readily available radiation sources, such as cobalt units, linear accelerators, or betatrons might provide some of the advantages associated with heavy particle therapy. (UK)

**19962** VESICOENTERIC FISTULA. Vargas, A. D.; Quattlebaum, R. B. Jr.; Scardino, P. L. (Memorial Medical Center, Savannah). Urology (Ridgewood, N. J.); 3: No. 2, 200-203(Feb 1974).

Experience with 9 cases of vesicoenteric fistula is presented. Of these cases 6 were secondary to diverticulitis of the sigmoid colon; 1 was secondary to regional enteritis; and 2 were caused by complications of radiation necrosis. Clinical characteristics, methods of diagnosis, and management are discussed. A one-stage surgical repair is the best method of treatment for inflammatory fistulas. In radiation fistulas and those associated with neoplasia, a multiple-staged procedure is required. (auth)

**19963** CARCINOMA ASSOCIATED WITH IRRADIATION OF THE IMMATURE BREAST. Iknayan, H. F. (Crawford Memorial Hospital, Robinson, IL). Radiology; 114: No. 2, 431-433(Feb 1975).

In two women who had undergone radiation therapy at ages one and eleven years, respectively, carcinoma in a hypoplastic breast developed. Each patient was treated by radical mastectomy. One patient is presently being followed without evidence of metastases; the other died of sarcoidosis following thoracotomy. A history of irradiation, hypoplasia and microscopic findings compatible with radiation changes suggests that these two cases of carcinoma may be radiation-induced. (auth)

**19964** RADIOLOGICAL DIAGNOSIS OF INJURIES OF IRRADIATED ESOPHAGUS. Rotte, K. H.; Lessel, A.; Eichhorn, H. J. (Zentralinstitut fuer Krebsforschung, Berlin). Radiobiol.-Radiother.; 15: No. 5, 561-572(1974). (In German).

The consequences and complications of curative radiation therapy of esophagus carcinoma with their radiological features are described. The open perforation into the tracheobronchial system, mediastinum and into the large vessels is regarded as the most feared complication. Depending on the irradiation dose between 14 and 30% of cases perforations could be observed. Compared to conventional X-ray deep therapy an increase in perforations with simultaneous increase in total tumor annihilation could be observed with the use of ultrahard radiation. Among the irradiation consequences on neighbouring organs radiation pneumonitis and fibrosis as well as mediastinitis only have a certain importance. However, they became rarer with the use of modern irradiation methods of the esophagus. (auth)

**19965** RADIATION-INDUCED INJURY FOLLOWING CONVENTIONAL RADIOTHERAPY OF LARYNGEAL CARCINOMA. Ulkowski, M. Pol. Przegl. Radiol. Med. Nukl.; 38: No. 5, 607-612(1974). (In Polish).

In the years 1960 to 1967, 398 patients with laryngeal carcinoma were treated at the Department of Radiotherapy, Institute of Radiology in Warsaw. It was found that the most frequent complication following conventional radiotherapy (observed in 63.1% of cases) was chronic laryngeal edema which was not life threatening and was quite transient but required constant observation since it could mask recurrence of the neoplasm in about 50% of cases. Acute radiation-induced edema occurred in only 2% of cases. Other changes included incompetence of vocal chords in 6.3% of cases, necrosis of laryngeal cartilages in 2.8% (which was not above the generally accepted risk of radical radiotherapy), while scar formation in the larynx with stenosis of its lumen and hypertrophy of mucosa with excessive keratinization was very rare (0.25% of cases), skin necrosis on the neck developed in 1% of cases. The rarity of severe damage after radiotherapy speaks in favor of this method of treatment in properly selected cases of laryngeal carcinoma because it is possible to achieve cure with maintained voice in a considerable proportion of cases. (auth)

**19966** ODONTOMA FORMATION IN THE JAW FOLLOWING IRRADIATION OF AN ADOLESCENT. Ostrowski, M. J. (Queen Elizabeth Hospital, Birmingham, Eng.). Brit. J. Radiol.; 47: No. 564, 897-900(Dec 1974).

A survey of the experimental evidence for the effects of radiation on the development of teeth in young mammals, together with clinical observations in man, demonstrated that gross changes in tooth morphology result from radiation interference with the normal maturational sequences of growth. A case history is given of a female patient who developed odontomas following courses of radiotherapy at the ages of 13 and 18 years for mixed parotid tumors of the left posterior cheek. Wisdom teeth failed to develop in the left lower jaw. The development of the odontomas could be attributed to the courses of irradiation at the time when the seventh and eighth molars were developing. (UK)

**19967** DECREASED SURVIVAL RELATED TO IRRADIATION POSTOPERATIVELY IN EARLY OPERABLE BREAST CANCER. Stjernsward, J. (Institut Suisse de Recherches Experimentales sur le Cancer, Lausanne, Switzerland). Lancet; No. 7892, 1285-1286(30 Nov 1974).

An increased mortality in early breast cancer could be correlated to the routine use of local postoperative irradiation. The decreased survival was statistically significant. Of controlled clinical trials so far published, all six, including more than 3400 patients, demonstrated decreased survival of between 1 and 10% in irradiated patients when compared with those treated by mastectomy alone. (auth)

**19968** RADIOPROTECTION IN THE INSTALLATION OF LIGHTING-RODS EQUIPPED WITH RADIOACTIVE SOURCES. Besseghini, G.; Zampini, F. G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 80-87(1974). (In Italian).

Administrative and radioprotection problems are discussed, related to the installation of lighting-rods equipped with radioactive sources. Results are reported of the survey of the level of radioactive contamination in plants with 8 to 10 years half lives in industrial atmospheres. The level of radioactive contamination is acceptably low, but periodical checking is advisable. Assembling as well as dismantling of the equipment should be committed to operators aware of practical principles of radioprotection. (auth)

**19969** FURTHER EDUCATION IN RADIATION HYGIENE. Carach, J. (KHS Bratislava (Czechoslovakia)); Skokanova, K. (KHS Stredoceskeho Kraje, Prague (Czechoslovakia)). Cesk. Hyg.; 19: No. 3, 133-136(Apr 1974). (In Czech).

From 10th Liskutin symposium; Hradec Kralove, Czechoslovakia (25 Apr 1973).

The topics are listed, both theoretical and practical, to which the syllabus of further education should be focused in further education of personnel with basic knowledge of radiation hygiene. The scope and the methods of further education in this field reflect the development of radiation hygiene together with the development of peaceful uses of atomic energy and of ionizing radiation experienced in the last two decades. (INIS)

**19970** BASIC CONCEPTS AND PRINCIPLES OF ASSESSMENT. A Review of the Advisory Committee Report on the Biological Effects of Ionizing Radiation. Villforth, J. C. (Bureau of Radiological Health, Rockville, MD). pp 3-13 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The present concepts of a single upper limit for individual and population doses, with the understanding that the risks should be kept as low as practicable, may not be adequate for the future uses of nuclear radiation. This is because of the potential for exposing large populations from the uses of nuclear power and medical radiation. There is a need to compare the biological risks and benefits of radiation applications and its alternatives. The recommendations of the US National Academy of Sciences–National Research Council's Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) are presented. The Committee estimates of the genetic, somatic and ill health risks from population exposures of 170 mrem are included. (auth)

**19971** POPULATION EXPOSURE AND THE INTERPRETATION OF ITS SIGNIFICANCE. Martin, A.; ApSimon, H. (Associated Nuclear Services, London). pp 15-26 of Population Dose Evaluation and Standards for Man and his Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The dose commitment approach in assessing the significance of radioactivity released to the environment is discussed. The detriment resulting from population exposure is discussed in terms of risk, loss of life, and in monetary terms. Estimates of the dose commitments for unit releases of tritium, carbon-14, and krypton-85 are given. The commitments are expressed in three ways, namely to individual members of a standardized critical group, to the whole UK population, and to the global population. The results for tritium release are very dependent on assumptions as to washout and deposition of atmospheric tritium. The estimates of dose commitment from tritium are higher than previous estimates and suggest that, taking account of their respective yields in nuclear reactors, tritium is of greater radiological significance than krypton-85. Attention is drawn to the much greater significance of carbon-14 as a source of population exposure. In a discussion of the detriment resulting from population exposure, it is suggested that loss of life, expressed in man years, is a more meaningful unit than risk. The problems of assessing the detriment in monetary terms are discussed and some illustrative costs are presented, expressed in terms of "V", the average valuation of one year of life. The question as to whether it is appropriate to apply economic discounting techniques is examined. (auth)

**19972** RADIATION PROTECTION: RISKS AND CONSEQUENCES. Delpla, M.; Hebert, J. (Electricite de France, Paris). pp 27-36 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

As a contribution to better understanding between the public health specialist and the lawyer, the authors define risk and damage, first as they are used in French law, and then as they are used in radiation protection. By way of example they employ the mathematical model of the public health specialist in calculating theoretical collective damage (somatic and genetic). The lawyer is looking for a system of presumptions to simplify the task of proving a causal relationship and he may be misled by abuse of the damage concept (particularly if it is not made clear that the damage in question is theoretical). (auth)

**19973** ACTION THRESHOLDS AND RADIATION PROTECTION. Delpla, M.; Vignes, S. (Electricite de France, Paris). pp 37-51 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The hypothesis on which the calculations of the public health specialist rest are set forth. The main one, the hypothesis that the added risk deriving from irradiation is proportional to the dose, is then considered on the basis of a number of examples of threshold dose rate values obtained with animals even for such very radiosensitive processes as lymphopoiesis and spermatogenesis. There follow a number of other examples for animals and for man of dose thresholds in relation to somatic and genetic effects, and even to beneficial effects observed after the receipt of doses below the threshold value. Such thresholds are related to the phenomenon of active and possibly complete recovery, accompanied by a high degree of selection, especially genetic selection. Efforts should be made to determine precisely what doses produce no observable effect or even produce beneficial effects. (auth)

**19974** USE OF THE RISK CONCEPT AND COST-BENEFIT ANALYSIS IN THE SAFETY ASSESSMENT OF NUCLEAR INSTALLATIONS. Simpson, D. M.; Winkler, B. C.; Tattersall, J. O. (Atomic Energy Board, Pretoria). pp 55-69 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The risk concept adopted by the Licensing Branch of the South African Atomic Energy Board for use in the safety assessment of nuclear installations is described. Standards for the population average risk resulting from the presence of a nuclear installation are defined and from this a radioactive release criterion is specified that relates the accidental release magnitude to per-

missible frequency of occurrence. Individual and population average dose limits are also derived for the normal operational release condition. Some problem areas in the use of such a risk concept are identified and discussed. An inconsistency in the use of a linear dose-effect relationship in relation to a defined population at risk is discussed. The use of the concept in defining the measures of population control around the site and the extent to which emergency procedures are implemented are also described. Although the application of the risk concept is a step towards a more rational approach to reactor siting and safety, in the opinion of the authors a cost-benefit approach is the technique which should be actively pursued. Some possibilities for the application of such a technique are discussed. (auth)

**19975** PREDICTION OF POPULATION DOSES DUE TO RADIOACTIVE EFFLUENTS FROM NUCLEAR INSTALLATIONS. Clarke, R. H. (Central Electricity Generating Board, Berkeley, Eng.); Goddard, A. J. H.; Fitzpatrick, J. pp 71-82 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Studies on the siting and safety aspects of nuclear installations have been made more comprehensive recently by the development of fast and economical computer programs describing the complex pathways by which radioactivity finds its way from irradiated fuel to man. Within the CEGB the WEERIE program has been developed to evaluate inhaled doses to adult human body organs, cloud $\beta$ and $\gamma$ doses and the ground deposition from discharges of airborne effluents under normal operational or accident conditions. WEERIE may thus be used to generate spatial distributions of dose to a variety of organs and the possibility arises of integrating the dose isopleths with real population distributions to assess population doses, which may then be combined with UNSCEAR figures for risks per $10^6$ man-rads. In the paper the methodology used to set up the evaluation of population dose using economical methods developed for the storage, retrieval and modification of population data is described. As illustrative examples of the work, population dose evaluations are made for $^{85}Kr$ discharges from a reprocessing plant. The major contributions to population dose are identified, the effects of cutting off dose contributions at 1% of background doses are investigated and the results presented as contours of equal population dose. (auth)

**19976** ESTIMATION OF POPULATION DOSE COMMITMENTS DURING THE EXAMINATION OF SAFETY REPORTS ON FRENCH NUCLEAR POWER STATIONS. Candes, P.; Slizewicz, P. (CEN de Saclay, Gif-sur-Yvette, France). pp 95-106 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

After describing briefly the French legislation relating to the safety of nuclear facilities, the authors examine in greater detail the way in which population dose commitments or potential population doses are estimated. The administrative procedures are of fairly recent origin and their formulation coincided with a considerable growth in the number of major facilities. One purpose of a safety assessment is to make the prospective operator ask himself about the effects that the facility will have on the environment and in particular about the constraints placed on future industrial development over an area that may extend for tens of kilometres around the site. It appears to be increasingly difficult at present to assess the safety of a nuclear facility without taking into account the other facilities (nuclear or otherwise) located within a considerable radius. It is in the general context of the development of the nuclear industry in a given country or a group of countries that nuclear safety must be assessed. (auth)

**19977** BASIC CONCEPTS FOR ENVIRONMENTAL RADIATION STANDARDS. Rowe, W. D.; Richardson, A. C. B. (Environmental Protection Agency, Washington, DC). pp 117-130 of Population Dose Evaluation and Standards for Man and his Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The elements required for informed decisions in the establishment of standards to protect the public from the effects of environmental releases of radioactive materials are reviewed. These include explicit estimation of all potential health effects and an analysis of the costs and capabilities of effluent controls, as well as consideration of the overall benefit/cost balance for each type of activity releasing radioactive materials. Subsidiary issues are the distribution in time and over populations of potential health impacts and the possibility of different value judgements by different nations in situations where radioactive materials may cross international boundaries. It is concluded (1) that standards based on health considerations alone are not appropriate in the present age of widespread use of radioactive materials, (2) that consideration of benefit/cost tradeoffs and the cost-effectiveness of health risk reduction must be explicitly made in deriving quantitative radiation standards, and (3) that international agreement is required on the basis for control of global radioactive pollutants. (auth)

**19978** INDIVIDUAL AND COLLECTIVE DOSES IN THE LIGHT OF THE RECOMMENDATIONS OF ICRP. Jammet, H.; Mechali, D. (CEN, Fontenay-aux-Roses, France). pp 147-154 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

In activities involving exposure to radiation, protective measures must take into account both the individual and the population as a whole if their objectives are to be achieved. Hence the "individual dose" and "collective dose" concepts, the first of them being applied when the risks that might be incurred by individuals have to be kept within acceptable limits and the second when the burden that such activities might impose on the population as a whole is being assessed. The methods for ensuring that dose limits are respected have reached a high degree of perfection. Studies relating to the practical application of the "collective dose" concept should be pursued and elaborated. (auth)

**19979** CRITERIA AND STANDARDS FOR EVALUATING THE DOSE RECEIVED BY THE POPULATION IN AREAS AFFECTED BY NUCLEAR FACILITIES. Iranzo, E.; Diaz de la Cruz, F. (Junta de Energia Nuclear, Madrid). pp 167-181 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In Spanish).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Criteria are presented that should be taken into consideration in determining the exposure levels of the population living in the area affected by a nuclear facility during its normal operation and in deducing the total dose received from external exposure, inhalation of radioactive nuclides released with the gaseous effluents, and ingestion of food and water contaminated by gaseous and liquid releases of both types of effluent. Following these criteria, it is indicated what studies are necessary and what calculation programs are to be used in order to determine the zones that can be considered critical in the light of the meteorological and topographic characteristics of the area where the nuclear facility is situated, so as to define the critical population groups from the standpoint of inhalation and of individual external exposure, and to determine the total population that would be involved as far as genetic effects are concerned. Standards to be used in determining the critical areas connected with radioactive contamination of foodstuffs produced in the area affected by the facility and its incidence on the internal contamination of the population as a consequence of consumption of such food and of water affected by the direct release of liquid effluents and by the indirect effects of liquid and gaseous effluents are given. On the basis of these studies and appropriate calculation programs, it is shown how to determine the most suitable locations for external-exposure measurement apparatus and for samplers of gases, aerosols, foodstuffs, and water. A description is also given of the calculation programs to be used in establishing the total radiation dose received by the critical population groups and all others liable to be affected, to a greater or lesser degree, by the operation of the nuclear facility. (auth)

**19980** PREDICTION OF THE RADIOLOGICAL CONSEQUENCES ON A REGIONAL SCALE OF NORMAL WASTE DISPOSAL FROM NUCLEAR FACILITIES. Garnier, A.; Lacourly, G. (CEN, Fontenay-aux-Roses, France). pp 183-193 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man

and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

With the expansion of nuclear power generation and the increasing number of possible sites for new facilities, especially near existing sites or national frontiers, the method for evaluating the radiological consequences of the normal operation of nuclear facilities is bound to need further refinement. The concept of "dose received by the critical group" is being supplemented by the concept of "collective dose", which combines the exposures of the different population groups involved and serves as a basis for damage evaluation. The authors examine several criteria, in particular that relating to the extent of the affected zones and the number of persons exposed. Individual and collective doses as a function of distance from the source are compared for several typical situations. The result brings out both the advantages and the limitations of the collective dose concept. The authors then consider the diversity of the characteristics of the environment and the populations liable to be affected directly or indirectly by contamination of the environment or of foodstuffs following the disposal of waste from one or more facilities. By expressing the exposure of a population in terms of collective dose per unit amount of discharged activity, it is possible to delimit zones of relative hazardousness with respect to possible sites. This approach necessitates general studies (such as the compilation of basic data), which would also be useful in evaluating the consequences of non-radioactive discharges and which should be carried out on the basis of regional or international collaboration. (auth)

**19981** COST-BENEFIT STUDIES IN THE FIELD OF RADIATION PROTECTION (METHODOLOGICAL ASPECTS). Bresson, G.; Fagnani, F.; Morlat, G. (CEN, Fontenay-aux-Roses, France). pp 195-216 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In French).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Cost-benefit analysis is a method of facilitating the decision-making process, which has been employed with varying degrees of success in connection with a number of economic and social questions. Regardless of where it is employed, it rests on certain general principles and simplifying assumptions. While these principles are relatively clear in the case of a commercial enterprise, it being possible to analyze any decision from the point of view of its financial consequences (for example, its impact on profits), this is not so when one is dealing with a broad question that has implications extending beyond this context. To some extent, radiation protection is such a question. Some radiation protection problems can be treated purely in terms of the unit of production (for example, a nuclear power station). However, if one does not take into account all the interactions between this and other units of production, which are governed by technical, economic and social relationships, one may well end by treating decision-making problems in too narrow a manner. At the general level, when formulating the problem, it is scarcely possible to ignore the existence of groups and institutions, which not only are not controlled by the authority responsible for the unit of production but may even be opposed to it: people living near the site, workers employed at the site, etc. Regardless of what is included when formulating the problem, consideration must also be given to how deeply it is intended to go in the analysis of the consequences of possible decisions; one can be more ambitious or less ambitious in describing these consequences and tracing the relations of cause and effect. Different levels of ambition will entail different methods of quantification, which may range from complete evaluation in monetary terms to simple quantification of the consequences in physical terms. The relationships between these methods, which are susceptible of analysis, the difficulties involved and the results that may be expected are discussed in general terms and illustrated by an example: the radiation protection of workers engaged in uranium ore extraction. (auth)

**19982** CURRENT PROBLEMS AND NEW CONCEPTS IN STANDARDS FOR THE EXPOSURE TO RADIATION OF WORKERS AND WHOLE POPULATIONS. Saurov, M. M.; Knizhnikov, V. A.; Turkin, A. D. (Biophysical Inst. of the Health Ministry, Moscow). pp 277-285 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974). (In Russian).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The availability of information on the occurrence of somatostochastic effects in persons exposed to radiation has created a need for new approaches in establishing a sound basis for the standards for permissible exposure. A critical analysis was made of the concept of acceptable risk and the concept of the impermissibility of actual risk was introduced for consideration. This concept is, essentially, that permissible risk should be interpreted as such risk of increased mortality from malignant neoplasms as cannot actually be detected in a given group of people throughout one generation. Adoption of the number of deaths from malignant neoplasms as the criterion for permissible risk requires partial reappraisal of the present classification of the critical organs. It is proposed that the division of the critical organs into groups should be governed by the damage caused by exposure of the organ to radiation as manifested by the development of neoplasms. It follows from the data on the dose/effect relationship given in the paper that, depending on the tumor yield per unit dose, the organs can be divided into three groups: Group I: red bone marrow, stomach, lungs and uterus; Group II: mammary glands, ovaries, kidneys, bladder, liver, intestine, pancreas, central nervous system, and any other organs except those contained in Groups I and III; Group III: bone, thyroid and skin. The mean permissible yearly dose (mean dose received by each member of a group or population) and yearly dose limit are established for workers and whole populations as a function of the numbers involved. The yearly dose limit makes allowance for probable non-uniformity of exposure. Mathematical expressions for determining the permissible risk and dose are quoted and numerical values given for permissible doses to the whole body and critical organs, both for occupationally exposed groups of different size and for the population as a whole. (auth)

**19983** MONITORING PROGRAMMES FOR THE DETERMINATION OF POPULATION DOSES. Ilari, O.; Polvani, C. (CNEN, Rome). pp 287-304 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

A review is presented of the principal problems of environmental monitoring aimed at the assessment of the population exposure, jointly with a discussion of their possible practical solutions. The two fundamental types of dose assessment (source-related and people-related) are recalled, also with reference to the cases of well-defined and of ill-defined sources of irradiation of the population. The problem of the cut-off point in the integration process of the individual doses to obtain the population dose is briefly discussed. The various approaches to the monitoring for the assessment of population exposure (direct approach, indirect approach, concentration factor method and systems analysis method) are illustrated, with reference to possible applications to actual situations. (auth)

**19984** RESULTS OF MEASUREMENTS RELATING TO THE POPULATION DOSE. Kiefer, H.; Koelzer, W.; Staeblein, G. (Karlsruhe Nuclear Research Center, Ger.). pp 305-316 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The Health Physics Division of the Karlsruhe Nuclear Research Center carries out a variety of radiation protection measurements for research purposes and as a routine procedure. Results obtained from such measurements that allow information to be generated about the exposure of members of the public are presented. A monitoring program for control of the environment of the Karlsruhe Nuclear Research Center with respect to radioactivity includes measurements and analyses, which by far exceed normal radiation protection requirements. The results provide a good survey of the radiation dose in the environment and, hence, of the external radiation exposure of the population in the environment. The external radiation exposure of all the persons working at the Center is monitored by the distribution of personnel dosimeters. In addition to persons occupationally exposed to radiation, all persons not exposed to radiation as a result of their work have also been equipped with dosimeters as a voluntary measure. Over the past ten years the average number of persons monitored was about 3000. For areas not involving significant occupational radiation exposure this resulted in values between 60 and 80 mrem/a, including natural radiation background. In mid-1973 a comprehensive measuring program was started to determine the radiation dose in private homes. Results of measurements conducted in more than 2500 private homes in Southern Germany are available. An influence of building material upon radiation exposure can be detected. (auth)

**19985** POPULATION DOSES FROM MEDICAL EXPOSURES. Larsson, L. E. (National Inst. of Radiation Protection, Stockholm). pp 369-375 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

During the past twenty years great effort has been devoted to the determination of genetically significant doses caused by medical radiological procedures while few corresponding surveys have been made to determine the appropriate population doses to such tissues and organs as the active bone marrow, thyroid, breast, lungs etc., that might be of interest in view of the present information on radiation-induced neoplasms. The available data on GSDs and somatic doses are discussed and the need for more information on somatic doses is demonstrated. (auth)

**19986** GENETICALLY SIGNIFICANT DOSE TO THE POPULATION IN INDIA FROM X-RAY DIAGNOSTIC PROCEDURES. Supe, S. J.; Rao, S. M.; Sawant, S. G.; Janakiraman, G.; Ganesh, A. (Bhabha Atomic Research Centre, Bombay). pp 395-411 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The genetically significant dose from x-ray diagnostic procedures has been measured in many countries. In the national programme for evaluation of the genetically significant dose to the population of India it was decided to estimate the same for the population of Eastern and Northern Regions of India and of Maharashtra and Tamil Nadu States, representing Western and Southern Regions. From these regions at least one major city, two urban cities and four to five district hospitals were selected for data collection so that the various types of medical facilities and radiographic techniques are represented. Age and sex distribution of patients undergoing various diagnostic examinations was collected from five sample districts of Tamil Nadu State, nine sample districts of Maharashtra, eight sample districts of Northern Region and eleven sample districts of Eastern Region. So far the age and sex distribution for more than 120,000 patients has been collected. Gonad dose measurements were carried out in major radiodiagnostic centres in these selected places. Gonad dose measurements have been carried out on as many as 15,000 patients. The child-expectancy factors were estimated from the data of Indian Census results on fertility rates and mortality rates. Evaluation of the annual genetically significant dose from the data yielded a much lower value compared to other countries. The annual genetically significant doses and gonad doses in a few examinations for India are compared with those from other countries. (auth)

**19987** PROBLEM OF THE ASSESSMENT OF THE RADIOLOGICAL IMPACT ON POPULATIONS FROM RADIOACTIVE DISCHARGES. Some Considerations on the Concept of Global Risk. Boeri, G.; Breuer, F.; Brofferio, C. (CNEN, Rome). pp 423-426 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Some particular aspects of the problem of evaluating the radiological impact on the population from radioactive effluent discharges are discussed. Generally, when this evaluation is made it is customary to consider dose commitments to the critical organs, neglecting doses to other organs. Since radioactive effluents from nuclear installations generally consist of many radionuclides with different critical organs and since even for a single radionuclide it is sometimes difficult to define a single predominant critical organ, the authors suggest considering in some cases a global risk factor that takes account of all the contributions to doses to the affected organs. (auth)

**19988** MISCELLANEOUS SOURCES OF IONIZING RADIATIONS IN THE UNITED KINGDOM: THE BASIS OF SAFETY ASSESSMENTS AND THE CALCULATION OF POPULATION DOSE. Wrixon, A. D.; Webb, G. A. M. (National Radiological Protection Board, Harwell, Eng.). pp 577-593 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

In the report miscellaneous sources are defined as material sources that might involve the general public. This definition includes such diverse sources as isotopic batteries for cardiac pacemakers, by-product gypsum used as a building material and luminous devices. The most common miscellaneous sources in the UK are reviewed and compared. The current UK legislation affecting the control of miscellaneous sources is described, together with relevant international recommendations. Since to evaluate the desirability of a given use the complete detriment from a source is required, a general method for calculating the population dose from a gamma-emitting source is described. It is concluded that even for a source emitting high energy gamma radiation under extreme conditions of population distribution, only the doses to persons in the immediate vicinity of the source need be included to obtain the collective dose with sufficient accuracy. On this basis the current average UK gonad dose from miscellaneous sources is estimated to be in the range 0.2 to 1.0 mrad·yr$^{-1}$. (auth)

**19989** PERMISSIBLE DOSES OF IRRADIATION OF PATIENTS IN ROENTGENOLOGICAL INVESTIGATIONS. Sobol, I. S. Med. Radiol.; 20: No. 2, 39-43(Feb 1975). (In Russian).

In order to restrict radiation loads in roentgenological investigations taking the present level of therapeutic and prophylactic work conducted among the population into consideration the author proposes introduction of temporary permissible doses of irradiation of patients of 2 age groups: 18 to 40 years old and over 40. The mentioned doses are introduced mainly during prophylactic investigations. The permissible doses are not used in roentgenological investigations conducted on the basis of clinical, oncological, and vital indices. (auth)

**19990** RADIATION LOADINGS IN ROENTGENOLOGICAL INVESTIGATIONS. Sobol, I. S. Med. Radiol.; 20: No. 2, 26-34 (Feb 1975). (In Russian).

Data are presented on the increase in the number of roentgenological instruments, number of roentgenologists, roentgenological investigations, growth of population, and biological effects of small doses of low-energy x-ray radiation. To determine radiation loading on the patients, 3970 calculations of exposition doses in routine roentgenological investigations were carried out by ionization and chemical methods of dosimetry. Integral absorbed genetically significant doses were calculated and a comparative assessment given of radiation loading on the patients caused by roentgenoscopy, natural sources of ionizing radiation, and radioactive fallout. Other measures aimed at reducing radiation loading on the patients are listed. (auth)

**19991** GASTRIC AND INTESTINAL CHANGES IN RADIATION THERAPY OF THE ABDOMINAL CAVITY TUMORS. Neimeister, K. (Karl Marx Univ., Leipzig). Med. Radiol.; 20: No. 2, 7-12 (Feb 1975). (In Russian).

During examination of 800 patients subjected to radiation therapy of the abdominal cavity tumors, there was established different frequency of acute intestinal reactions (from 12 to 100%) depending on the zone and the dose of irradiation. On the basis of the results of studies of disorders of intestinal absorption and considerable clinical experience, the basis of dietetic nutrition of patients during irradiation of the stomach was elaborated. (auth)

**19992** HEMODYNAMICS OF GENERAL REGIONAL BLOOD CIRCULATION IN RADIATION THERAPY OF BRONCHUS CANCER. Strashinin, A. I.; Osipov, I. S.; Yakovlev, D. V.; Morozov, A. S.; Chupin, I. Ya. (All-Union Scientific-Research Inst. of X-ray and Radiology, Moscow). Med. Radiol.; 20: No. 2, 3-7 (Feb 1975). (In Russian).

Hemodynamic indices were studied with the help of the radiocardiography method and use of albumin of the human serum labelled by $^{131}I$ in 57 patients with bronchogenic cancer before and in the process of radiation therapy and in 25 patients with skin cancer who had no remote metastases and had not been subjected to radiation treatment. The decrease of cardiac output was noted in patients with bronchogenic cancer who had undergone radiation therapy. A total volume of the circulating blood and the stroke volume of the heart in these patients were practically unchanged. The change of the blood flow rate in the lesser circulation and the volume of the circulating blood in the lungs were closely connected and were in reverse relationship with each other. The authors think it possible to judge indirectly about the results of radiation therapy according to the change in the blood flow rate in the lesser circulation, the volume of the circulating blood in the lungs and cardiac output. (auth)

**19993** ABNORMALITIES IN SKELETAL UPTAKE OF $^{99m}Tc$ POLYPHOSPHATE COMPLEXES IN AREAS OF BONE ASSOCI-

ATED WITH TISSUES WHICH HAVE BEEN SUBJECTED TO RADIATION THERAPY. Cox, P. H. (Rotterdams Radio Therapeutisch Instituut, Netherlands). Brit. J. Radiol.; 47: No. 564, 851-856(Dec 1974).

A number of abnormalities in skeletal scintigrams were observed, which occurred in areas of bone in the proximity of tissues subjected to radiation therapy. It is thought that the effects observed were due to incidental irradiation of the bone areas during treatment. Explanations for the anomalies observed in the scintigrams are suggested. (auth)

**19994** RATE FIXING OF MEDICAL PERSONNEL'S WORK IN RADIODIAGNOSTIC LABORATORIES. Tarasenko, V. D.; Kozin, Ya. B. (Inst. of Medicine, Sverdlovsk, USSR). Med. Radiol.; 20: No. 2, 43-47(Feb 1975). (In Russian).

The general principles of rate fixing and methods of registration of work expenditures of the medical personnel of radiodiagnostic laboratories were analyzed. Radiation loads of physicians and radiotechnicians of radiodiagnostic laboratories even with the most uprofitable industrial situations very seldom exceed 1/5 of PDD, therefore in everyday practice it is expedient to make an assessment only of a temporary component of operating load of the personnel. To simplify calculations of operating load it is possible to use nomograms and tables compiled with due regard for practicable parameters characteristic of a concrete laboratory. (auth)

**19995** RADIOISOTOPES AND THE "10-DAY RULE". Sear, R. (London Hospital). Brit. J. Radiol.; 47: No. 563, 822-823 (Nov 1974).

The ruling from the Code of Practice for the Protection of Persons against Ionizing Radiations Arising from Medical and Dental Use (1972, Her Majesty's Stationery Office, London), which states that "To reduce the likelihood of irradiation of a pregnancy, examinations involving the lower abdomen should, if practicable, be carried out within 10 days following the first day of the menstrual period", should be extended to cover hazards created by the use of radioisotopes for diagnostic purposes. The only common radioisotopic materials which can result in an embryonic dose in excess of 0.5 rad is normal clinical use are $^{75}$Se methionine and $^{67}$Ga citrate; the effective half-life of several weeks in the human body for $^{75}$Se methionine means that the application of the "10-day rule" does not provide an adequate safeguard, in contrast to $^{67}$Ga citrate, which has an effective half-life of about 2 days. In addition the particular hazards created by radioisotopic materials which can cross the placental barrier (e.g. radioiodine, even when administered before conception) are also emphasized. (UK)

**19996** TECHNIQUES AND RADIATION IN MAMMOGRAPHY. Young, G. B. (Royal Infirmary, Edinburgh). Brit. J. Radiol.; 47: No. 563, 811-815(Nov 1974).

The increased use of mammography in the diagnosis and follow-up of breast cancer means that with repeated yearly screenings, apparently dangerous levels of radiation may be produced. It is therefore important to keep the rads per exposure low. Three aspects of mammography were considered, with this aim in view. (i) The dose from a particular machine can be altered very little and so care in initial selection is necessary. (ii) The techniques for the production of diagnostically acceptable mammograms were compared. The readily available commercial films were used with and without tungsten back screens in the preparation of mammograms from a Kodak mammography phantom. Significant reductions in radiation (down to a dose of 0.2 rad per exposure) could be obtained by suitable selection of film and the use of the tungsten back screen. (iii) The advantages of automatic processing were assessed and related to the different films studied. (UK)

**19997** ABSORBED DOSE/EXPOSURE CONVERSION FACTORS FOR MINERAL BONE. Koren, K. (Stratens Inst. for Straalehygiene, Oslo). Brit. J. Radiol.; 47: No. 563, 790-794(Nov 1974).

In order to determine the absorbed dose in bone a knowledge of the rad/R conversion factor f is needed for various radiation conditions. A revised version of the curve of f vs half-value layer (ICRU, 1964, Physical Aspects of Irradiation (Report 10b) National Bureau of Standards Handbook 85, Washington, D.C.) is presented. Twin spherical ionization chambers, one of which had its internal electrode covered with aluminum foil, were used to determine the HVL at different depths in water, for a range of HVLs of the incident beam from 0.09 to 2.14 mm Cu and for field sizes from 4 to 400 cm$^2$. The results (for the extreme field sizes) are presented graphically, while the resulting f values are given in tabular form. The dependence of f on the radiation parameters, including waveform and kV/filtration, is stressed. (auth)

**19998** ELASTOSIS IN CHRONIC RADIODERMATITIS. Ledoux-Corbusier, M.; Achten, G. (Univ., Brussels). Brit. J. Dermatol.; 91: No. 3, 287-295(Sep 1974).

The electron microscopic study of six cases of chronic radiodermatitis from sun-exposed and unexposed skin, confirms the observation of elastosis previously described with light microscopy. The pathological findings are comparable with those found in actinic elastosis; increased width of the fibres, irregularity of their shape, increased density and granularity of the microfibrils and holes with many lobes in the matrix. The findings may be due to transformation of elastic fibres into elastotic fibres or the formation of dystrophic elastotic fibres by dermal fibroblasts. (auth)

**19999** RADIATION PHYSICS AND RADIATION HYGIENE IN THE USE OF DENTAL X-RAY APPARATUS. II. The Dental X-Ray Apparatus. Johansen, J. (Statens Institutt for Straalhygiene, Oslo). Nor. Tannlaegeforen. Tid.; 83: No. 10, 429-434 (Nov 1973). (In Norwegian).

Following a brief general introduction to x-ray tubes the importance of electric potential, apertures, focussing and filters are discussed. The effect of electric current and the importance of accurate time measurement in minimizing the radiation dose are stressed. (NO)

**20000** RADIATION PHYSICS AND RADIATION HYGIENE IN THE USE OF DENTAL X-RAY APPARATUS. III. Radiation Hygiene. Moe, A. J. (Statens Institutt for Straalhygiene, Oslo). Nor. Tannlaegeforen. Tid.; 83: No. 11, 486-492(Dec 1973). (In Norwegian).

Procedures and practices to optimise the results and minimise the radiation doses to both patients and personnel in dental radiography are described and discussed. Placing and shielding of radiographical equipment, and films and their development are also discussed. (NO)

**20001** DOSIMETRIC ANALYSIS OF METHODS OF RADIATION TREATMENT OF THE URINARY BLADDER TUMORS. Pospelova, I. I. (Inst. of Medicine, Leningrad). Med. Radiol.; 20: No. 2, 12-15(Feb 1975). (In Russian).

The article presents dosimetric analysis of a number of the most frequently used methods of radiation treatment of the urinary bladder tumor on the basis of determining an integral absorbed dose in the whole body of the patient taking into consideration the requirements of radiation loads produced on the vitally important organs and healthy tissues. (auth)

**20002** MANAGEMENT OF EXTENSIVE, LOCALIZED NEOPLASMS OF LOWER ABDOMINAL WALL. Skinner, D. G. (Univ. of California, Los Angeles). Urology (Ridgewood, N. J.); 3: No. 1, 34-37(Jan 1974).

Good palliation and, in some cases, apparent cures have resulted after surgical treatment of patients with extensive, localized epidermoid carcinoma occurring in the lower abdominal wall or prevesical space. Other localized neoplasms, such as radiation-induced sarcomas, also may be amenable to similar treatment. En bloc pubic resection and the scrotal skin transfer technique were used successfully to facilitate removal of an extensive, recurrent, epidermoid carcinoma in 1 patient and a necrotic radiation-induced fibrosarcoma in another. Principles of management include exploratory laparotomy to rule out the possibility of disseminated disease, and stint dressings and suction catheters placed beneath the scrotal flaps to prevent fluid accumulation. (auth)

**20003** INVESTIGATIONS ABOUT CHANGES IN ENZYME ACTIVITY ON THE SKIN CAUSED BY X-RAYS. P. 1. Beta-Glucuronidase. Soltesz, L.; Bathori, E. (Magyar Tudomanyos Akademia, Budapest. Orvosradiologiai Kutato Csoport). Strahlentherapie; 148: No. 2, 195-202(Aug 1974). (In German).

Changes in the activity of beta-glucuronidase in the skin of mice after application of 100, 500 and 1,000 R of soft x rays were tested. The tests were performed right after irradiation and 1, 2, 4, 8, and 16 days later. The total activity of the skin was measured as well as the enzyme activity elutriated from the skin and the remaining enzyme activity after eluation. The amount of beta-glucuronidase enzymes elutriated from the skin is extremely low; the activity values in the solution used for eluation were higher than the control values in each of the three doses and at any moment of the experiment; the enzyme activity of the solution increases intensively, immediately after irradiation in relation to the applied dose; on the second day following irradiation with 100, 500, and 1,000 R a marked increase of the enzyme activity was also measured in the solution; the activity of the homogenate was significantly increased on the second day, but only by the effect of 500 R; after an x-ray irradiation with 1,000 R, a new wave of activity increase was observed in both, solution and homogenate, beginning from the fourth post-irradiation day. (auth)

**20004** ON THE COLLECTIVE RADIATION DOSE LIMIT AND THE EFFICIENCY OF POWER PRODUCTION. Tiainen,

O. J. A.; Seppae, M.; Kortelainen, P. (Helsinki Electricity Works (Finland)). Atomkernenergie; 24: No. 1, 67-68(1974).

The maximum allowed collective dose caused by nuclear electricity production was proposed to be 1 manrem per 1 MW year (MWa) generated electrical energy. The paper shows that the total efficiency of power production may be used to determine the allowed collective doses. In studies of various energy production alternatives the advantages of the proposed concept are shown. (GE)

**20005** BETATRON IRRADIATION PLANNING BY A DESK COMPUTER WITH PROGRAMMING DEVICE. Ihnen, E.; Wendhausen, H. (Kiel Univ. (F. R. Germany). Radiologische Klinik). Strahlentherapie; 148: No. 2, 146-154(Aug 1974). (In German).

Description of programs for a desk computer for planning of treatment with static fields of electrons and x-rays of the 42 MeV betatron. (auth)

**20006** MANUAL ON RADIATION PROTECTION IN HOSPITALS AND GENERAL PRACTICE. Volume 1. Basic Protection Requirements. Braestrup, C. B.; Vikterloef, K. J. Geneva; World Health Organization (1974). 81p. Sw.fr. 12.-.

The manual as a whole deals with the radiation protection of patients, occupationally exposed persons, and the public and is written for the reader having a basic general knowledge of radiation and biology. The present volume, the first of the series, is a general review of the radiation protection requirements common to all medical applications of ionizing radiation and radionuclides. Other volumes will discuss separately and in much greater detail the special applications of radiation, such as unsealed radionuclides (nuclear medicine), x-ray diagnosis, dental radiography, and conventional radiotherapy. For any one field of interest it is essential to use this first volume in conjunction with the appropriate specialized volume. (HLW)

## Vertebrates

*Refer also to abstracts 19558, 19853, 21926, 21927, and 21938.*

**20007** (AEC-tr-7602) RADIOBIOLOGY. Translation of Radiobiologiya; 14: No. 4, 475-639(1974). 217p. Dep. NTIS $7.60.

Separate abstracts were prepared for the 41 articles in this English translation of Radiobiologiya. (HLW)

**20008** (AEC-tr-7602, pp 41-46) INFLUENCE OF THE "TIME FACTOR" OF IRRADIATION ON PROCESSES OF DAMAGE AND RESTORATION OF HEMATOGENESIS IN MICE. Chertkov, K. S. 1974. Translated from Radiobiologiya; 14: No. 4, 507-511(1974).

In Radiobiology.

In experiments on hybrid mice $F_1$ (CBA × C57B1), irradiated for 123 sec or 47 hrs at a dose of 800 R, the changes in the cell composition of the bone marrow, thymus, spleen, and peripheral blood were studied. In the investigated organs, after prolonged irradiation, a large number of cells is preserved; processes of repopulation begin earlier and end in a more complete restoration in comparison with the indices in animals irradiated briefly at the same dose. Processes of recovery of cells after prolonged and brief irradiations are simulated by an exponential function. The rate of recovery in mice irradiated briefly is 1.1 to 3.6 times as high. (auth)

**20009** (AEC-tr-7602, pp 47-51) INFLUENCE OF EXTERNAL BETA AND X IRRADIATION ON THE TRANSKETOLASE ACTIVITY OF RAT SKIN. Matyushichev, V. B.; Taratukhin, V. R.; Ashmarin, I. P.; Glushankov, E. P. (Leningrad State Univ.). 1974. Translated from Radiobiologiya; 14: No. 4, 512-515(1974).

In Radiobiology.

The influence of total x irradiation of white rats at doses of 100 and 500 R, as well as external $\beta$ irradiation with $^{85}Kr$ in doses of 3.05 and 4.45 krad, separately and in combinations, on the transketolase activity of the skin was investigated 5, 12, 19, and 26 days after the radiation burden. It was shown that with a low general radiosensitivity, this enzyme system exhibits specificity of the postradiation response. (auth)

**20010** (AEC-tr-7602, pp 52-58) FACTORS CONTROLLING THE RECIRCULATION OF STEM CELLS. Communication 1. Influence of Adrenalectomy on the Migration of Hematogenic Stem Cells from Bone Marrow Shielded During Irradiation. Khaitov, R. M.; Petrov, R. V.; Moroz, B. B.; Bezin, G. I. 1974. Translated from Radiobiologiya; 14: No. 4, 516-521(1974).

In Radiobiology.

The influence of bilateral adrenalectomy on the intensity of the migration of hematogenic stem cells from shielded portions of the bone marrow of mice after irradiation with x rays at a lethal dose was studied. It was established that in adrenalectomized mice there is a sharp intensification of the migration of stem cells from the bone marrow, regardless of the volume of the shielded portion. Adrenalectomy did not influence the exogenous colonization of the spleen in mice subjected to whole-body irradiation at a lethal dose, but stimulated the endogenous colonization in sublethally irradiated animals. In adrenalectomized nonirradiated mice an increased number of stem cells circulates in the peripheral blood. It was concluded that a cutoff of the function of the adrenals leads to an intensification of the discharge of stem cells from the bone marrow into the circulation. (auth)

**20011** (AEC-tr-7602, pp 59-65) PROTEIN-SYNTHESIZING ABILITY ISOLATED RAT SPLEEN NUCLEI AFTER BRIEF AND PROLONGED IRRADIATION AND THE ADMINISTRATION OF $\beta$-MERCAPTOETHYLAMINE. Korzhova, L. P. 1974. Translated from Radiobiologiya; 14: No. 4, 522-527(1974).

In Radiobiology.

Definite patterns and peculiarities of the action of brief and prolonged irradiation of rats at various doses of $\gamma$ rays, comparable in magnitude and efficiency, on the protein-synthesizing ability of isolated spleen nuclei were detected. It was shown that MEA has a different influence on the process studied under conditions of prolonged irradiation of animals in comparison with the action of the aminothiol in the case of brief irradiation. A hypothesis is advanced on the causes of the ineffectiveness of MEA in the case of prolonged irradiation. (auth)

**20012** (AEC-tr-7602, pp 66-69) COMPARISON OF THE RADIOPROTECTIVE ACTION OF $\beta$-MERCAPTOETHYLAMINE ACCORDING TO THE SURVIVAL OF MICE AND ACCORDING TO ITS INFLUENCE ON THE YIELD OF SPLEEN ENDOCOLONIES. Konoplyannikov, A. G.; Konoplyannikova, O. A. (Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 522-527(1974).

In Radiobiology.

In experiments on noninbred white mice it was found that the radioprotective action of $\beta$-mercaptoethylamine, tested according to the 30-day survival after irradiation and according to the yield of spleen endocolonies, can be described in terms of the decrease in the effective dose of irradiation with DRF $1.31 \pm 0.09$ and $1.38 \pm 0.10$, respectively. These data agree with the concept that the hemotogenic stem cells are determinants of the survival of animals in the bone marrow range of doses of irradiation. (auth)

**20013** (AEC-tr-7602, pp 70-76) QUANTITATIVE CHANGES IN VARIOUS CELL GENERATIONS OF THE BONE MARROW OF DOGS AFTER A SINGLE WHOLE-BODY GAMMA IRRADIATION. Belousova, O. I.; Trushina, M. N. 1974. Translated from Radiobiologiya; 14: No. 4, 522-527(1974).

In Radiobiology.

In order to detect the dose versus effect and time versus effect dependence, the change in the cell composition of the bone marrow and peripheral blood of dogs after $\gamma$ irradiation was studied. (auth)

**20014** (AEC-tr-7602, pp 89-94) MECHANISM OF THE DEVELOPMENT OF POSTRADIATION HEMOSTATIC DISORDERS. Ponomarev, Yu. T.; Nosatovskii, I. A.; Aladatov, A. G. (Inst. of Medical Radiology, Obninsk, USSR). 1974. Translated from Radiobiologiya; 14: No. 4, 545-549(1974).

In Radiobiology.

The influence of isologous plasma fibrin-stabilizing factor (factor XIII) on the phase of formation of fibrin, the structure and properties of a blood clot, and the functional properties of the blood platelets in acute radiation sickness in dogs was studied in experiments in vitro. It was established that the introduction of a preparation of factor XIII into the blood of irradiated animals leads to normalization of the fibrin-stabilizing activity of the blood, an increase in the tolerance of a fibrin clot to the lytic action of plasmin, and an increase in the ability of the blood platelets for processes of adhesion and aggregation. A normalization of the ultrastructure of the fibrin fibers and fibrin clot formed was noted electron microscopically. The opinion is expressed that the disruption of a number of the most important links in the system of hemostasis during acute radiation sickness is associated with a decrease in the activity of the blood factor XIII. (auth)

**20015** (AEC-tr-7602, pp 95-101) SIGNIFICANCE OF THE MECHANISMS OF HOMEOSTATIC REGULATION IN THE DETERMINATION OF INDIVIDUAL DIFFERENCES IN RADIOSENSITIVITY. Pospisil, M. (Inst. of Biophysics, Brno). 1974. Translated from Radiobiologiya; 14: No. 4, 550-554(1974).

In Radiobiology.

The problems of individual differences in the radiosensitivity of mammals are described. The dependence of the individual

radiosensitivity on regulatory functions is discussed. On the basis of the results, which demonstrate the interrelationship between individual manifestations of radiosensitivity and the equilibrium of electrolytic functions, activation of the adrenal cortex, release of serotonin, and metabolic activity, the concept of the role of differences in the effectiveness of the homeostatic regulatory mechanisms in the individual manifestations of radioresistance was formulated. (auth)

**20016** (AEC-tr-7602, pp 115-120) RADIOPROTECTIVE ACTION OF MEXAMINE AND CYSTAMINE IN THE IRRADIATION OF MICE AT VARIOUS PERIODS OF POSTNATAL DEVELOPMENT. Timoshenko, S. I.; Bogatyrev, A. V.; Sverdlov, A. G. (Leningrad Inst. of Nuclear Physics). 1974. Translated from Radiobiologiya; 14: No. 4, 564-567(1974).

In Radiobiology.

The most pronounced radioprotective action of mexamine is manifested in two and three-week-old mice and sexually mature mice. Cystamine is highly effective in the protection of one, two, and three-week-old mice and sexually mature mice. Both protectors are less effective in the case of irradiation of four-week-old mice. (auth)

**20017** (AEC-tr-7602, pp 126-131) RADIOSENSITIVITY OF CERTAIN SPECIES OF SMALL MAMMALS AND THE POSSIBILITY OF ADAPTATION OF A POPULATION OF RODENTS TO ARTIFICIAL POLLUTION OF THE BIOGEOCOENOSIS WITH STRONTIUM-90. Il'enko, A. I.; Isaev, S. I.; Ryabtsev, I. A. (Inst. of Evolutionary Morphology and Ecology of Animals, Moscow). 1974. Translated from Radiobiologiya; 14: No. 4, 572-575(1974).

In Radiobiology.

The radioresistance of six species of rodents was investigated: northern redbacked voles (Clethrionomys rutilus), common redbacked voles (C. glareolus), common voles (Microtus subavalis), wood mice (Apodemus sylvaticus), field mice (A. agrarius), and harvest mice (Micromis minutus). The genus of common redbacked voles is more radioresistant than the other rodents. The populations of northern redbacked voles and wood mice, inhabiting regions polluted with $^{90}Sr$ for 14 years, have a tendency for adaptation to this environmental factor. The mortality of the animals was not the same in the groups of animals from the polluted and control regions after a single supplementary irradiation with $\gamma$ rays of $^{60}Co$. (auth)

**20018** (AEC-tr-7602, pp 132-136) DNA-DEPENDENT RNA POLYMERASE OF THE ORGANS OF IRRADIATED ANIMALS. Communication 2. Nucleoplasmic RNA Polymerase (Form B) from the Liver and Spleen Nuclei of White Rats. Likhoded, V. S.; Savenko, L. N.; Paskevich, I. F. (Inst. of Medical Radiology, Kharkov). 1974. Translated from Radiobiologiya; 14: No. 4, 576-579(1974).

In Radiobiology.

RNA polymerase was isolated from rats 48 hrs after irradiation; DNA was isolated from the liver and spleen 24, 48, and 120 hrs after irradiation. A table is presented to show activity of RNA polymerase from the liver and spleen of non-irradiated and irradiated rats using DNA from control and irradiated rats. RNA polymerase was substantially freed of accompanying proteins and this led to a significant increase in its specific activity in RNA synthesis. (HLW)

**20019** (AEC-tr-7602, pp 140-142) CONTENT OF SOLUBLE POLYDEOXYRIBONUCLEOTIDES IN DNP IN TISSUES OF IRRADIATED RATS AFTER THE INTRODUCTION OF HIGH-POLYMER DNA. Rysina, T. N. 1974. Translated from Radiobiologiya; 14: No. 4, 581-583(1974).

In Radiobiology.

Rats were given a single whole-body dose of 800 R gamma radiation. Before and after irradiation they were given intraperitoneal injections of high-polymer DNA from rat spleens. Rats were killed 3, 6, and 24 hrs after irradiation and fractionation of DNA was carried out in the bone marrow, spleen, small intestine, and liver. A graph is presented to show content of DNA in fractions of DNP and PDN of various tissues. (HLW)

**20020** (AEC-tr-7602, pp 146-150) INFLUENCE OF COMPLEX PREPARATIONS OF VITAMINS C AND P ON THE ENERGY METABOLISM IN LIVER MITOCHONDRIA OF IRRADIATED RATS. Naumova, G. M.; Rudakov, N. P. (Inst. of Problems of Oncology, Kiev). 1974. Translated from Radiobiologiya; 14: No. 4, 586-589(1974).

In Radiobiology.

Irradiated rats were given subcutaneous injections of galascorbin or galascorbin-2 in doses of 50 and 100 mg/kg; some rats were given 10 mg/kg doses of ascorbic acid. Respiration of mitochondria was determined at intervals up to 28 days after irradiation. The tabulated results show that the preparations prevent sharp changes in the energy metabolism of the liver mitochondria of irradiated animals. (HLW)

**20021** (AEC-tr-7602, pp 151-153) RAPID CHANGES IN THE METABOLIC ACTIVITY AND THEIR RELATIONSHIP TO THE RADIOSENSITIVITY OF MICE. Goshek, B.; Mishustova, Ya.; Novak, L. (Inst. of Biophysics, Brno). 1974. Translated from Radiobiologiya; 14: No. 4, 589-591(1974).

In Radiobiology.

Measurements of oxygen consumption were conducted on mice kept in a thermostatically controlled chamber from April to June. The mice were then irradiated at a dose of 610 R and the death of the animals was recorded for a period of 30 days. Approximately 54% of the experimental mice died. A definite relationship was observed between radiosensitivity and fluctuation of oxygen consumption. (HLW)

**20022** (AEC-tr-7602, pp 154-157) INFLUENCE OF IONIZING RADIATION ON THE LEVEL OF THIOLS IN THE BLOOD, LIVER, AND ITS STRUCTURES. Glushchenko, N. N.; Danilov, V. S.; Kozlov, Yu. P. (Moscow State Univ.). 1974. Translated from Radiobiologiya; 14: No. 4, 591-593(1974).

In Radiobiology.

Rats were irradiated and killed at intervals up to 72 hrs later. Procedures are described for determining SH groups in the blood, erythrocytes, blood serum, and liver and for determining thiol content of microsomes. During the development of acute radiation sickness, a decrease in the level of total sulfhydryl groups and low-molecular thiols occurred. (HLW)

**20023** (AEC-tr-7602, pp 158-161) DEPENDENCE OF THE CELL CONTENT OF THE BONE MARROW AND MUCOSA OF THE SMALL INTESTINES OF DOGS ON THE DOSE OF FAST NEUTRONS AND THE GAMMA RADIATION OF $^{60}Co$. Shaporov, V. N.; Avestisov, G. M.; Chernov, E. N. 1974. Translated from Radiobiologiya; 14: No. 4, 594-596(1974).

In Radiobiology.

Dogs were given 110 to 670 rad doses of gamma-neutron radiation and 120 to 1300 rad doses of gamma radiation. The dogs were killed and bone marrow and jejunum were prepared for microscopic study. The destruction of bone marrow and intestinal cells proceeded according to an exponential law. The maximum destruction of bone marrow cells occurred on the seventh and 14th days after irradiation, and the maximum destruction of intestinal cells occurred on the fifth to the seventh day. (HLW)

**20024** (AEC-tr-7602, pp 167-171) RADIOPROTECTIVE EFFECT OF SHIELDING OF THE BONE MARROW IN MICE IRRADIATED AT VARIOUS PERIODS OF POSTNATAL DEVELOPMENT. Bogatyrev, A. V.; Timoshenko, S. I.; Nikanorova, N. G.; Shabarova, A. I. (Leningrad Inst. of Nuclear Physics). 1974. Translated from Radiobiologiya; 14: No. 4, 600-603(1974).

In Radiobiology.

Mice of various ages were given 300 to 1000 R x radiation. The hind limb of some mice was shielded with a lead plate. The effect of shielding was evaluated according to the 30-day survival and according to the number of endogenous colonies in the spleen. The least protective effect of shielding occurred in the newborn mice. (HLW)

**20025** (AEC-tr-7602, pp 172-176) PECULIARITIES OF THE RADIOPROTECTIVE ACTION AND TOXICITY OF CYSTAPHOS IN THE CASE OF INTRAVENOUS INJECTION. Znamenskii, V. V.; Zherebchenko, P. G.; Terekhov, A. V. 1974. Translated from Radiobiologiya; 14: No. 4, 604-607(1974).

In Radiobiology.

Mice were given intravenous and intraperitoneal injections of cystaphos and gamma irradiated at a dose of 900 R. Results indicated that the radioprotective action of cystaphos occurred more rapidly in the case of intravenous injection than in the case of intraperitoneal injection. Similar results were obtained when experiments were conducted on dogs. When experiments were conducted using cystamine and cysteamine, these drugs were more toxic in the case of intravenous injection than in the case of intraperitoneal injection. (HLW)

**20026** (AEC-tr-7602, pp 177-181) STUDY OF THE RADIOPROTECTIVE ACTIVITY OF CERTAIN DERIVATIVES OF 5-METHYLBENZO-2,1,3-THIADIAZOLE. Vladimirov, V. G.; Strel'nikov, Yu. E.; Belen'kaya, I. A.; Kostyukovskii, Ya. L.; Tsepova, N. S. (Military-Medical Academy, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 4, 607-610(1974).

In Radiobiology.

Mice were intraperitoneally injected with derivatives of 5-methylbenzo-2,1,3-thiadiazole 30 min before irradiation. Radioprotective activity was determined according to 30-day survival of the mice. Results indicated that the most effective radioprotector was 4-hydroxy-5-methylbenzo-2,1,3-thiadiazole. Com-

pounds that are comparatively difficult to oxidize in vitro to the corresponding quinone proved to be effective as radioprotectors. (HLW)

**20027** (AEC-tr-7602, pp 182-185) RADIOPROTECTIVE PROPERTIES OF β-HYDROXY- AND β-MERCAPTOTRYPTAMINES AND THEIR DERIVATIVES. Vasin, M. V.; Antipov, V. V.; Suvorov, N. N.; Orlova, L. M.; Vinograd, L. Kh.; Shalygina, O. D. 1974. Translated from Radiobiologiya; 14: No. 4, 610-612(1974).

In Radiobiology.

Derivatives of β-hydroxy- and β-mercaptotryptamines were injected intraperitoneally into mice before they were given 850 R gamma radiation. The radioprotective effect was evaluated according to the 30-day survival. The tabulated results show that the indole analog of noradrenalin is more effective as a radioprotective agent than tryptamine. The introduction of a thiol group into the β position of the alkyl chain of tryptamine increases the radioprotective effect. (HLW)

**20028** (AEC-tr-7602, pp 186-189) HEMOSTATIC ACTION OF SEROTONIN AND MEXAMINE IN EXPERIMENTAL ACUTE RADIATION SICKNESS. Katsev, V. M.; Golubentsev, D. A.; Martirosov, K. S. (Military-Medical Academy, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 4, 613-615(1974).

In Radiobiology.

Serotonin and mexamine were administered to guinea pigs and rats during hemorrhagic syndrome following gamma irradiation. Serotonin exhibited a distinct antihemorrhagic effect; serotonin adipate was more effective than serotonin in the form of a salt of creatinine sulfate. A good hemostatic effect of mexanine was detected when it was used in higher doses in comparison with serotonin. (HLW)

**20029** (AEC-tr-7602, pp 190-192) POSTRADIATION EFFECT OF HYPEROXIA ON RATS IRRADIATED WITH X RAYS. Ivanov, I. F. (Inst. of Roentgenology, Kiev). 1974. Translated from Radiobiologiya; 14: No. 4, 616-618(1974).

In Radiobiology.

Rats were given whole-body x radiation at doses of 800 to 1100 rad and were placed in chambers with an oxygen content of 86 to 94%. The injurious effect of oxygen was determined according to the mortality of the rats during a five-day period. As the duration of oxygenation increased in the postradiation period, there was a gradual decrease in the value of the median lethal dose. The injurious effect extended to the bone marrow and to the intestinal form of the radiation sickness. (HLW)

**20030** (AEC-tr-7602, pp 193-196) DYNAMICS OF POSTRADIATION RECOVERY AT THE ORGANISMIC LEVEL IN THE CASE OF X IRRADIATION IN A BROAD RANGE OF NONLETHAL DOSES. Eliner, G. I.; Stepanov, A. I.; Filatov, P. P. (Inst. of Radiation Hygiene, Leningrad). 1974. Translated from Radiobiologiya; 14: No. 4, 618-620(1974).

In Radiobiology.

Rats were given 20 to 400 R doses of x radiation and electroencephalographs of the bioelectric activity of the brain were made after 3 hrs, 1 and 3 days, 1, 2, 3, and 4 weeks, and each successive month after irradiation. Results showed that the bioelectric activity increased exponentially as a function of dose. Doses up to 100 R were compensated without leaving irreversible damage, while doses exceeding 100 R led to pronounced damage and could be classed as alteration doses. (HLW)

**20031** (AEC-tr-7602, pp 197-201) CHANGES IN THE STRUCTURES OF THE SYNAPTIC DEVICES UNDER IONIZING INFLUENCES. Tkachenko, Z. Ya.; Demidova, G. G. (Inst. of Molecular Biology and Genetics, Kiev). 1974. Translated from Radiobiologiya; 14: No. 4, 621-624(1974).

In Radiobiology.

Rabbits were given 300 to 1400 R x radiation. The solar plexus, the stellate ganglion, and the intramural plexuses of the stomach and vermiform appendix were isolated. The nerve structures were examined by electron microscopy and histological changes are described. Synapses were characterized by a rarefaction and clarification of the matrix, a swelling of ultrastructures, and partial lysis of membranes. A distinct ability for recovery was noted in the synaptic structures and different levels of radiosensitivity among the structures were noted. (HLW)

**20032** (AECL-5018, pp 43-49) POPULATION RESEARCH BRANCH. Newcombe, H. B. Nov 1974.

In Biology and Health Physics Division progress report, July 1 – September 30, 1974.

The backs of rats were painted with tobacco tar in a test for a possible multiplicative synergistic effect on cancer risk from combined exposure to radiation and environmental chemical carcinogens. A computer program to link records of human handicapping conditions, hospitalizations, and deaths among children, back to the appropriate birth records, has been tested using files arranged in three alternative sequences to ensure that virtually all potentially linkable pairs of records are brought together for comparison regardless of errors in information used to create a particular sequence. The results from this test have provided the basis for further necessary revisions of the program. (CH)

**20033** (AED-CONF-74-440-004) INFLUENCE OF THE LET-VALUE ON THE RELATIVE RADIOSENSITIVITY OF HYPOXIC TUMOR CELLS IN THE SOLID SARCOMA 180, EXTERNAL MEASUREMENTS USING LABELLED IODODEOXYURIDINE. Porschen, W.; Feinendegen, L. E.; Muehlensiepen, H.; Bosiljanoff, P.; Piepenbring, W. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Medizin). 1974. 5p. (In German). (CONF-741068-2). INIS.

From annual meeting of the German Biophysic Society; Freiburg im Breisgau, F. R. Germany (2 Oct 1974).

A method was developed to analyze the cell loss rates in the living organism in the case of solid experimental tumors. This method was used for analyzing the relative radiation sensitivity of hypoxic tumor cells in sarcoma 180 after irradiation with γ rays, 15-MeV neutrons, or α particles. The tumor cells were first labelled in vivo with $^{125}$I-DU, after 50 hours with $^{131}$I-DU. The tumor measuring unit developed by the authors permits external determination of the cell loss rate for two differently labelled tumor cell areas with different oxygen partial pressure in the span of 80 to 170 hours. The external measurements of gamma activity were confirmed by a biochemical analysis. After irradiation with $^{137}$Cs gamma rays (2,000 or 4,000 R), for each dose value two different cell loss rates, which differ by a factor of 2.5, were observed. If the gamma irradiation is done after injecting nitrofuran, this factor is reduced to about 1.5. After irradiation with 15-MeV neutrons (300 or 500 Rad), two cell loss rates, differing by a factor of 1.4, were observed. A fourth group of tumors were irradiated internally with alpha particles from the reaction $^{10}B(n,\alpha)^{7}Li$ (30 μg/g-boron-10). The local tumor irradiation took place with thermal neutrons in a thermal column at the FRJ-1 reactor, MERLIN. Hardly any difference in cell loss rates was observed on irradiation with high LET (340 or 680 Rad). The quotients of the (standard) cell loss rates for the above-mentioned types of radiation (average LET value about 0.4; 12; or 150 MeV keV/μ) agree well with the oxygen enhancement ratios as found in in-vitro experiments by other authors. (GE)

**20034** (CONF-731005-) CELL CYCLE IN MALIGNANCY AND IMMUNITY. Proceedings of the Thirteenth Annual Hanford Biology Symposium at Richland, Washington, October 1–3, 1973. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 605p. Dep. NTIS $13.60.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

Separate abstracts were prepared for five of the 37 papers included in these proceedings. An abstract of one other paper appeared in Vol. 30 of NSA as abstract number 00667. The other 31 papers are not sufficiently within the scope of NSA for abstracts to be included. (ERB)

*For abstracts of individual papers see: 19936, and 20035–20038.*

**20035** (CONF-731005-, pp 156-181) PERTURBATIONS OF CELLULAR KINETICS BY PHYSICAL AND CHEMICAL AGENTS. Frindel, E. (Institut de Radiobiologie Clinique, Villejuif, France). 1975.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

In cell cycle in malignancy and immunity.

Modifications caused by drugs and radiation, particularly effects on the duration of the cell cycle, the growth fraction, and the temporary blocks in the cycle, are studied. The consequences of these modifications and of selective killing lead to two types of phenomena: (1) A reassortment of the age distribution in the population studied. This reassortment is reflected by a semisynchronization of the cells. (2) Recruitment of quiescent cells. These phenomena must be taken into consideration when dealing with phase-dependent drugs because recruitment and synchronization occur not only in tissues to be eradicated but also in normal tissues. It is important to keep this in mind during fractionated treatments with physical or chemical agents. (auth)

**20036** (CONF-731005-, pp 182-192) CHROMATID AND HALF-CHROMATID ABERRATIONS IN CHINESE HAMSTER CELLS X-IRRADIATED IN METAPHASE, PROPHASE, OR $G_2$. Dewey, W. C. (Colorado State Univ., Fort Collins). 1975.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

In cell cycle in malignancy and immunity.

The types and frequencies of chromosomal aberrations were studied both in cells not delayed in their cycle by x irradiation, i.e., located beyond an X-marker existing 10 min prior to prophase, and in cells delayed by irradiation, i.e., located in $G_2$ prior to the X-marker. Cells located beyond the X-marker at the time of irradiation, i.e., cells in metaphase, prophase, and in late $G_2$ within 10 min of prophase, were physically separated from cells located prior to the X-marker by mitotic selection to collect the cells as they entered metaphase and anaphase. These mitotic cells were fixed immediately or were allowed to traverse one cell cycle before they were fixed. When cells reached their first metaphase following irradiation, those irradiated prior to the X-marker manifested chromatid deletions and exchanges, but those irradiated beyond the X-marker sustained no visible aberrations. However, when prophase and metaphase cells were treated with Colcemid for 60 min following irradiation, gaps and chromatid deletions appeared. Thus, in cells located beyond the X-marker, there was neither division delay nor evidence of aberrations. Only when a delay was artificially produced with Colcemid did aberrations begin to appear. When cells reached their second metaphase following irradiation, both those prior to and beyond the X-marker at the time of irradiation sustained only chromosome deletions and exchanges. This finding contrasts with a previous observation of a high frequency of chromatid type deletions and exchanges in cells x-irradiated in metaphase following a 2-hr treatment with Colcemid and then scored for aberrations in the next metaphase. Thus, true half-chromatid exchanges, which are evidenced by chromatid exchanges in the second metaphase, normally do not occur to any appreciable extent in cells irradiated in metaphase, prophase, or in $G_2$ prior to the X-marker. However, the bineme nature of the mitotic chromatid can be readily observed in radiation studies if metaphase cells are treated with Colcemid prior to x irradiation. (auth)

**20037** (CONF-731005-, pp 193-210) RADIATION-INDUCED DIVISION DELAY IN CHO CELLS: REPAIR KINETICS. Leeper, D. B. (Thomas Jefferson Univ. Hospital, Philadelphia). 1975.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

In cell cycle in malignancy and immunity.

The kinetics of the recovery from radiation damage manifest as division delay has been analyzed in Chinese hamster ovary fibroblasts in monolayer culture using two-dose fractionation schemes and suboptimal postirradiation temperatures in a manner similar to the analysis of the repair of sublethal and potentially lethal radiation damage. Mitotic-cell selection was used to assess the rate of cell division. Fractionation of a single dose of 300 rads into two 150-rad fractions separated by intervals of time and analysis of the division delay remaining at the time of the second dose have shown that the damage resulting in division delay is repaired at a constant rate of 1 min of delay per minute between dose fractions. However, when a 600-rad single dose was fractionated into two 300-rad fractions, a bimodal-recovery pattern resulted. After a dose of 300 rads, damage manifest as division delay was repaired initially (up to 0.4 hr postirradiation) by a rapid recovery process at the rate of 3.6 min of delay per minute between dose fractions, after which a second and slower recovery process became operant, with damage being repaired at the rate of 0.55 min of delay per minute between dose fractions. Lowering the postirradiation incubation temperature to 4, 20, or 30°C or lowering the temperature between two-dose fractions reduced the rate of recovery. The construction of an Arrhenius plot showed that the repair process was enzymatic with an activation energy of 11,000 cal/mole and a $Q_{10}$ of 1.82. Neither fractionation nor postirradiation treatment with suboptimal incubation temperatures modified the recovery from division delay in a way that resembled the recovery from sublethal or potentially lethal radiation damage. This provides further evidence that the respective radiosensitive targets are distinct. (auth)

**20038** (CONF-731005-, pp 211-223) CELL KINETICS IN THE SKIN OF MICE ONE YEAR AFTER IRRADIATION WITH CYCLOTRON-ACCELERATED HELIUM IONS. Leith, J. T.; Schilling, W. A.; Welch, G. P.; Tobias, C. A. (Univ. of California, Berkeley). 1975.

From 13th Hanford biology symposium on the cell cycle in malignancy and immunity; Richland, Washington, USA (1 Oct 1973).

In cell cycle in malignancy and immunity.

The cell kinetics of the dorsal skin of the mouse were studied 1 year after irradiation with low-energy helium ions. The labelled mitoses curves of mouse epidermis for dose levels of 75 to 2000 rads indicate that the lowest dose at which definite disturbance in epidermal cell kinetics may be found is 1200 rads. At this dose level and higher levels, the epidermis is characterized morphologically by the presence of a persistent hyperplastic epithelium. This acanthotic epidermis is associated with an increased duration of the $G_1$ phase of the cell cycle, a slower turnover time, and a greater number of cells with the ability to synthesize DNA per unit length of epidermis. (auth)

**20039** (FMI-1000-591) LOCALIZATION AND RADIOTOXICITY OF $Na^{99m}TcO_4$ IN THE MOUSE FETUS. Lathrop, K. A.; Gloria, I. V.; Harper, P. V. (Chicago Univ., Ill. (USA)). 1974. Contract AT(11-1)-69. 3p. (CONF-740926-5). Dep. NTIS $4.00.

From 1st world congress of nuclear medicine and exhibition meeting; Tokyo, Japan (30 Sep 1974).

The results with prior administration of $NaClO_4$ show that the localization of $^{99m}Tc$ from $Na^{99m}TcO_4$ in the feto-placental unit is reduced by about one-half during the last week of the three weeks of gestation. No adverse effect of $NaClO_4$ on the fetus is apparent from the daily administration of 15 mg, the equivalent of about 35 g per day in the human. It would appear that the radiation absorbed dose to the fetus can be reduced substantially in clinical studies with $Na^{99m}TcO_4$. The differences in concentration of $^{99m}Tc$ observed between fetal and maternal organs suggest that the early high concentration in fetal blood and organs associated with erythrogenesis and the low initial content of the thyroid gland may indicate that $^{99m}Tc$ is carried to the fetus in some form other than pertechnetate then subsequently released and redistributed as pertechnetate. These differences also will result in different distributions of radiation absorbed doses in the fetus and the mother. A comparison of the effects of radiation from $^{99m}Tc$ biologically distributed after administration as $Na^{99m}TcO_4$ with the effects of external x-radiation is difficult. Estimation of the radiation absorbed doses for the animals in this study are of the order of 1 rad total for the 5 $\mu$Ci groups and 100 rad for the 500 $\mu$Ci groups. The weight reduction in the latter groups is similar to that observed after 100 r of x-radiation (5). No data appear to be available for lower doses of x-radiation. Persistent reduction in body weight in successive generations as compared to normal animals in the same environment at the same time may indicate a genetic effect. (auth)

**20040** (GSF-PG-1) WORKING MEETING ON GENETICS OF THE GSF, MAY 24-25, 1973 IN GRUENBACH. Book of Abstracts. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Koeln (F. R. Germany). Abt. fuer Pflanzengenetik). Apr 1974. 31p. (In German). (AED-CONF-73-696-000; CONF-7305111-). INIS.

From working meeting on genetics; Gruenbach, F. R. Germany (24 May 1973).

With abstracts in English.

Summaries of lectures given at the working meeting on genetics are included. The two lectures on x-ray-induced specific-locus mutation rates in newborn and young mice and on the mutagenic effect of irradiation on primordial germ cells of mice are of particular interest. (GE)

**20041** (JPRS-63856) SPACE BIOLOGY AND AEROSPACE MEDICINE, VOL. 8, NO. 6, 1974. Translation of Kosm. Biol. Aviakosmicheskaya Med.; 8: No. 6, 3-83(1974). 147p. NTIS.

Papers are presented concerning the selection and training of cosmonauts; evaluation and analysis of accumulated data to facilitate the on-going transition from orbital to interplanetary flights; research aimed at guaranteeing safety on long flights and reliability of the human component of the man-spaceship system; space psychology and physiology; environmental problems and control (spacecraft habitability, effects of radiation and weightlessness, etc.) and telemetry. Separate abstracts were prepared for three papers. (HLW)

*For abstracts of individual papers see: 20042–20044.*

**20042** (JPRS-63856, pp 26-32) EFFECT OF 50-MeV PROTONS ON THE TESTES OF MICE. Fedorenko, B. S.; Kondratenko, V. G.; Stakanov, V. A.; Bayrakova, A.; Babaev, I.; Khlaponina, V. F. 1974. Translated from Kosm. Biol. Aviakosmicheskaya Med.; 8: No. 6, 16-19(1974).

In Space Biology and Aerospace Medicine, Vol. 8, No. 6, 1974.

The biological effect of 50-MeV protons and $^{60}Co$ gamma rays on the testes of mice has been studied pathomorphologically, cytogenetically and cytofluorimetrically. The results show that both types of penetrating radiations in similar doses induce responses and pathological processes. The dose dependence of cytogenetic effects and nuclear changes in spermatogenic cells was discovered in a later research stage. These changes were followed by poorly expressed pathomorphological disorders. In comparison with gamma-irradiation, protons with an energy of 50-MeV exhibit a lesser biological effectiveness. (auth)

**20043** (JPRS-63856, pp 33-40) DEVELOPMENT OF TUMORS IN DOGS EXPOSED OVER A LONG PERIOD TO LOW DOSES OF EXTERNAL GAMMA IRRADIATION. Yakovleva, V. I. 1974. Translated from Kosm. Biol. Aviakosmicheskaya Med.; 8: No. 6, 20-24(1974).

In Space Biology and Aerospace Medicine, Vol. 8, No. 6, 1974.

Over a six-year period 150 animals were exposed to chronic (with a dose of 21, 63 and 125 rad per year and a dose rate of 0.06, 0.17 and 0.34 rad per day respectively) and combined (chronic irradiation with a dose of 63 rad per year and acute irradiation with a dose of 58 and 126 rad per year) gamma irradiation. An autopsy of 74 irradiated animals revealed malignant neoformations (planocellular lung cancer, hepatocellular liver cancer, skin basalioma, osteogenic rib sarcoma and eye melanoma) in five dogs, benign neoformations (three leidigomas, parenchymatous struma of the thyroid gland and angiofibroma of subcutaneous connective tissue) in five animals. An examination of 19 control dogs revealed mammary tumors (cystadenoma and adenofibroma developing into adenocarcinoma) in two animals. The greatest number of neoformations was found in the animals exposed to chronic irradiation with the highest dose rate and in the animals that had received the highest total doses during chronic irradiation. (auth)

**20044** (JPRS-63856, pp 41-46) MODIFICATION OF THE CYTOGENETIC EFFECT OF IONIZING RADIATION UNDER THE INFLUENCE OF PERMANENT MAGNETIC FIELDS. Galaktionova, G. V.; Strzhizhovskii, A. D. 1974. Translated from Kosm. Biol. Aviakosmicheskaya Med.; 8: No. 6, 25-28(1974).

In Space Biology and Aerospace Medicine, Vol. 8, No. 6, 1974.

The modifying effect of a permanent magnetic field of 1,000 to 4,500 oe on post-radiation changes in the mitotic index and the frequency of aberrant mitoses in the corneal epithelial cells of mice was investigated. A three-hour exposure to a permanent magnetic field of 4,500 oe immediately before or after irradiation in a dose of 400 rad exerted an insignificant effect on the cytogenetic effect of ionizing radiation. A five-day exposure of animals to a permanent magnetic field of 1,000 oe after irradiation produced no modifying influence on the radiation effect. Irradiation of mice after their 15-day exposure to a permanent magnetic field of 1,000 oe did not alter the post-radiation inhibition of mitotic activity and increased the level of its recovery. This effect also reduced the yield of radiation-induced chromosomal aberrations and brought about no significant changes in the rate of their elimination. (auth)

**20045** (RLO-2225-T2-6) LOW LEVEL CHRONIC IRRADIATION OF SALMON. Annual Progress Report. Hershberger, W. K.; Donaldson, L. R.; Bondam, K.; Brannon, E. L. (Washington Univ., Seattle (USA). Coll. of Fisheries). 2 Jul 1974. Contract AT(45-1)-2225-T2. 25p. Dep. NTIS $4.25.

Results are reported from studies on the effects of chronic exposure of chinook salmon during the early stages of development (fertilization to yolk absorption) to $\gamma$ radiation delivered at dose rates varying from 0.5 R/day to 50.0 R/day and a cumulative dose up to 3850 to 4000 R. Detailed records were kept of the radiation exposures, growth rate; abnormalities, mortality, and smoltification during the early stages of development. After a period of rearing, the irradiated and control fish were tagged and released to migrate to sea. After one to four years in the sea the adults that migrated back were examined and subsequently $F_1$ progeny were examined. The most marked effect of chronic irradiation was to decrease ocean survival of the salmon. Other indications of injury caused by irradiation included sterility of some males and retardation of initial development following exposure to 20.0 R/day for a cumulative dose of 1620 R during the 81-day incubation period. Progeny of the irradiated fish were also examined for genetic effects of irradiation but no single gene differences were found in $F_1$ progeny that could be explained by radioinduced changes. (CH)

**20046** (STI/DOC-10/160) LABORATORY TRAINING MANUAL ON THE USE OF NUCLEAR TECHNIQUES IN ANIMAL PARASITOLOGY: IMMUNOLOGY AND PATHOPHYSIOLOGY. (International Atomic Energy Agency, Vienna (Austria)). 1974. 169p. IAEA $8.00.

Basic principles for lecture material are presented in the first section. Some topics discussed are: properties of radionuclides and radiations; radioactive decay; interaction of radiation with matter; radiation detection; liquid scintillation counting; radiation protection; internal exposure; waste disposal; and neutron activation analysis. Twenty-five laboratory exercises are presented in the second section; some examples are experiments with a G-M counter; experiments with a scintillation counter; rapid radioactive decay; and neutron activation analysis for silver. The third section consists of lecture material for applications of basic principles. Some topics discussed are: radiochemical purity; radiation effects; procedures with animals; handling of samples; and parasitological applications. Fifteen laboratory exercises on applications are presented. Some examples are: separation procedure for protein mixtures; immunodiffusion; complement fixation test; radiation-attenuated vaccines; and measurement of albumin pools. Appendices describing various techniques are also included. (HLW)

**20047** RADIOSENSITIZING EFFECT OF DEHYDROEPIANDROSTERONE. Sonka, J. (Charles Univ., Prague). pp 105-114 of Advances in Chemical Radiosensitization. Vienna; International Atomic Energy Agency (1974).

From proceedings of a panel on advances in chemical radiosensitization; Stockholm, Sweden (25 Jun 1973). See STI/PUB-368; CONF-7306110-.

Dehydroepiandrosterone (DHEA) as an inhibitor of glucose-6-phosphate dehydrogenase, NADH-oxidase and cytochrome P 450, may reduce the growth and regeneration of tissues. In some respects a similar effect may be produced by x-irradiation. The radiosensitizing effect of this non-toxic steroid was confirmed on irradiated mice, the survival of which was reduced if 1 mg of DHEA or 1.4 mg of DHEA-sulphate was injected in a single dose from 16 to 48 h before irradiation (700 R, x-rays). A more pronounced effect was observed if DHEA was injected for three consecutive days before irradiation. Some healthy men and women have a low plasma DHEA and a very low DHEA urinary output (zero urinary values may be present in one quarter of healthy blood donors). In cancer DHEA blood values are reduced and urinary zero values are prevalent. Because the combination of irradiation and DHEA pretreatment may enhance the survival of Krebs ascitic mice, a similar treatment was suggested for patients suffering from cancer and having no urinary DHEA. On the other hand, persons with a lack of DHEA are expected to be radioresistant. (auth)

**20048** VARIATION IN RADIOSENSITIVITY WITHIN THE CELL CYCLE OF EARLY PREIMPLANTATION MOUSE EMBRYOS. DuFrain, R. J. Ithaca, New York; Cornell Univ. (1974). 218p. University Microfilms Order No. 74-29,911. Thesis (Ph. D.).

The first cleavage of BlOSJ $F_1$ mouse ova fertilized by BLU: Ha (ICR) sperm was initiated at the same time as in ova from BLU: Ha (ICR) mice, but the second and subsequent cleavages occurred significantly earlier in the BlOSJ $F_1$ embryos. Duration of the two-cell interphase period for in vivo development was calculated to be 18.4 ± 0.8 hours for BlOSJ $F_1$ embryos and 21.9 ± 0.8 hours for the BLU: Ha (ICR) embryos. The four-cell interphase period for embryos developing in vitro was found to be 12.3 ± 2.2 hours for the BlOSJ $F_1$ embryos and 14.7 ± 3.1 hours for BLU: Ha (ICR) embryos. From the cell cycle length and tritiated thymidine uptake studies (four-cell stage, BLU: Ha (ICR) embryos in vitro), the lengths of the interphase stages were determined. No $G_1$ phase could be conclusively demonstrated. The S phase lasts for 9 hours following cleavage to the four-cell stage. The $G_2$ phase starts by 10 hours after cleavage and was calculated to last about 5 hours. Pronuclear one-cell embryos from BlOSJ $F_1$ females were irradiated in vitro 28 hours after HCG injection; observation of subsequent cleavages indicated a delay of 0.85 minutes per Roentgen of exposure in the second cleavage following irradiation (exposures up to 600 R). Development to the blastocyst stage was shown to be more sensitive than cleavage following pronuclear irradiation. The $E.D._{50}$ values for development to the two-cell and expanded blastocyst stages were calculated to be 757 ± 69 Roentgens and 126 ± 21 Roentgens, respectively. Embryos from BLU: Ha (ICR) mice were irradiated in vitro at the late two-cell stage, four different times during the four-cell stage and at the eight-cell stage of development. Individual analyses were carried out for development to the end points of morula formation, initiation of cavitation, completion of cavitation, initiation of hatching from the zona pellucida, and completion of hatching from the zona pellucida. The pattern of developmental arrest following irradiation was similar for all end points other than development to the morula stage, which was found to be extremely radioresistant. For development to the other end points, embryos irradiated at the two-cell and early four-cell stage were most sensitive. Radioresistance increased as embryos developed through the four-cell stage; eight-cell stage embryos were radioresistant for the end points used. Maximum cleavage delay was observed when four-cell embryos were irradiated immediately following cleavage. The duration of the induced cleavage delay decreased when irradiation was given at progressively later times following the observed cleavage. (Diss. Abstr. Int., B)

**20049** EFFECT OF IONIZING RADIATION ON PROTEIN METABOLISM IN STORED RAT SKIN. De Loecker, W.; Doms, D.; Stas, M. L. (Louvain Univ., Belgium). Radiat. Res.; 61: No. 2, 216-229(Feb 1975).

The inhibitory as well as stimulatory effects of irradiation on protein metabolism are preserved during storage of rat skin. Upon incubation of the tissue after storage, these effects can be evaluated. A single initial irradiation of 1500 R and 3000 R affects the free amino acid concentrations in the tissue and their release into the storage medium, as a result of an increased cellular destruction and protein degradation. A lower dose of 750 R reduces

the amino acid release, possibly as a result of a stimulatory effect on protein synthesis. In vitro irradiation of skin results in a stimulatory effect on the incorporation of [2-$^{14}$C] glycine into the proteins after subsequent incubation. (auth)

**20050** TESTS OF TWO ELECTRON-AFFINIC RADIOSENSITIZERS IN VIVO USING REGROWTH OF AN EXPERIMENTAL CARCINOMA. Denekamp, J.; Harris, S. R. (Mount Vernon Hospital, Northwood, Eng.). Radiat. Res.; 61: No. 2, 191-203 (Feb 1975).

Two electron-affinic nitroimidazoles were investigated as potential radiosensitizers using tumor regrowth as a measure of response. Both drugs, metronidazole, (May and Baker), and Ro-07-0582, (Roche), were effective radiosensitizers of hypoxic tumor cells. These sensitizers have previously been shown to be specific in that they are effective only on hypoxic cells and give no sensitization of well-oxygenated cells. Flagyl (metronidazole) gave an enhancement ratio of about 1.6 at 0.75 mg/g body weight. Ro-07-0582 sensitized both naturally occurring hypoxic cells in air-breathing mice, and acutely hypoxic cells in clamped tumors. It had a small effect when administered after irradiation with 2000 rads, and caused very slight slowing of tumor growth in unirradiated mice. Ro-07-0582 is the most effective sensitizer so far tested, giving an enhancement ratio of up to 2.1 when 1 mg/g is administered intraperitoneally. Since no enhancement of well-oxygenated normal tissue has been observed, this could correspond to a therapeutic gain factor of 2.1. (auth)

**20051** EFFECT OF IONIZING RADIATION ON LIPID METABOLISM IN BONE MARROW CELLS. Levis, G. M.; Efstratiadis, A. A.; Mantzos, J. D.; Miras, C. J. (Univ. of Athens). Radiat. Res.; 61: No. 2, 342-349(Feb 1975).

New Zealand rabbits were subjected to 500 rads of total-body irradiation. Bone marrow cells, 24 hr after irradiation, were incubated with [U-$^{14}$C]glucose for various time intervals, or with [1-$^{14}$C]K$^{+}$-palmitate. Ionizing radiation increased oxidation of [U-$^{14}$C]glucose while [$^{14}$C]palmitate oxidation was inversely affected. [U-$^{14}$C]Glucose is incorporated mainly as glycerol into neutral lipids and phospholipids. The major products of lipid biosynthesis from both precursors are triglycerides and phosphatidyl choline. Ionizing radiation increased the biosynthesis of triglycerides and phosphatidyl choline and decreased the percentage of total radioactivity incorporated into phosphatidyl ethanolamine. It is suggested that accumulation of lipids in the bone marrow of irradiated animals is partly due to increased lipogenesis. An explanation of this phenomenon is provided by the increased glucose catabolism through which increased glycerophosphate may be available for lipid biosynthesis. (auth)

**20052** RAPID SCREENING OF RADIOPROTECTIVE DRUGS IN VIVO. Heddle, J. A. (York Univ., Toronto); Harris, J. W. Radiat. Res.; 61: No. 2, 350-353(Feb 1975).

The traditional test for radioprotection, a measurement of the $LD_{50/30}$, requires a 1-mo wait between treatment and result. An alternative method is proposed which requires only a 3-day wait. It requires fewer mice but more man-hours than $LD_{50/30}$ measurement. The frequency of micronuclei which result from chromosomal aberrations is the criterion of damage. It is shown that a thiophosphate compound S-2-(3-aminopropylamino) ethylphosphorothioic acid (WR 2721) produced a similar protection measured in this way as had been found by the traditional method. (auth)

**20053** BIOLOGICAL INTERACTION BETWEEN RADIOFREQUENCY ELECTROMAGNETIC WAVES AND IONIZING RADIATION. Davydov, B. I.; Antipov, V. V.; Tikhonchuk, V. S. Cosmic Res. (USSR) (Engl. Transl.); 12: No. 1, 114-117(1974).

Translated from Kosm. Issled.; 12: No. 1, 129-133(1974).

After exposure first to an shf field (PFD = 10, 20, 40, and 100 mV · cm$^{-2}$, t = 40, 20, 10, and 4 min. respectively, duration 10 days) followed by $\gamma$-irradiation within a wide range of doses (400 to 20,000 R) the mean life span is reduced within dose ranges reflecting hematological death of the animals; biological interaction between electromagnetic waves and ionizing radiation can thus be regarded as a reaction of synergic character. At dose levels reflecting a lesion of the gastrointestinal tract no synergism is found. (auth)

**20054** INTERSTRAIN DIFFERENCES IN THE PARAMETERS OF ERYTHROPOIETIC RECOVERY AFTER AN ACUTE SUBLETHAL X IRRADIATION AND THEIR RELATION TO INTERSTRAIN DIFFERENCES IN RADIOSENSITIVITY AND EFFECTIVENESS OF HAEMOPOIETIC REGULATION IN MICE. Vacha, J.; Hola, J.; Sikulova, J.; Znojil, V.; Pospisil, M. (Inst. of Biophysics, Brno). Folia Biol. (Prague); 20: No. 6, 409-418(1974).

Using the method of $^{59}$Fe uptake in mouse erythropoietic organs (bone marrow and spleen), the time course of the recovery of erythropoiesis was followed after an acute sublethal x-ray exposure in several inbred strains of mice differing in the value of their $LD_{50/30}$. A positive correlation was found between the rate of recovery, assessed by the time required for erythropoiesis to reach its initial (preirradiation) level, and the $LD_{50/30}$ of the mouse strains tested. This relation holds for erythropoietic recovery in both femoral marrow and spleen, even though the time course of the repair processes differs substantially in the two organs. A negative correlation was further demonstrated between the common indicator of the effectiveness of regulation (i.e., the size of an area on the graph delineated by the curves of postirradiation oscillations and the line of the control level) and the $LD_{50/30}$ of the appropriate mouse strain. Both the rate of erythropoietic recovery and the type of damping of postirradiation oscillations can be considered as indicators of the effectiveness of regulatory processes that play a role in haemopoietic stem cell recovery; this effectiveness determines the ability of an organism to withstand radiation damage inflicted by exposures within the dose-range of the so-called marrow death. Finally, a positive correlation was found between the relative share of the spleen in the total $^{59}$Fe uptake in erythropoietic organs and radiosensitivity of individual mouse strains. (auth)

**20055** CHANGES IN TISSUE CIRCULATION IN THE BRAIN OF RABBITS IN BURNS, ACUTE RADIATION, AND COMBINED TRAUMAS. Bykov, G. A.; Sternin, M. Yu.; Malamud, M. D. (Inst. of Surgery, Moscow). Byull. Eksp. Biol. Med.; 78: No. 11, 29-31(Nov 1974). (In Russian).

Experiments were conducted on rabbits. A determination was made of tissue circulation in the brain with the aid of $^{133}$Xe in severe burns of 20% of body surface, total x-ray irradiation in a dose of 900 rad and combined action of both factors. Cerebral circulation proved to diminish to a lesser degree than the heart minute volume (by an average of 20 to 30 and 50%, respectively). With combined trauma reduction of cerebral circulation was the same as in case of an isolated burn or radiation affection. The results obtained testified to the presence of compensatory mechanisms directed to the preservation of cerebral circulation in case of a fall of the heart minute volume. (auth)

**20056** MORPHOLOGICAL CHANGES IN THE THYROID GLAND IN RATS FOLLOWING TOTAL-BODY AND INTERNAL IRRADIATION. Odinokova, V. A.; Kondalenko, V. F.; Vasil'eva, L. A. (Moscow Regional Scientific-Research Clinical Inst.). Arkh. Patol.; 36: No. 11, 49-54(1974). (In Russian).

Morphological changes in the thyroid gland of 159 rats 1-2½ years after total-body (x-rays) and internal ($^{131}$I) irradiation are described. Analysis of the data obtained showed that total-body, internal, and combined irradiation brought about in the thyroid gland of the animals not only changes the ultrastructure of cells A, B, C, but also induces cancer, the cells of which were characterized by a number of ultrastructural features. (auth)

**20057** TUMOR CONTROL AND REGROWTH PROBABILITY AFTER A SINGLE RADIATION OF EXPERIMENTAL ANIMAL TUMORS. Urano, M. (National Inst. of Radiological Sciences, Chiba, Japan); Fukuda, N.; Ando, K.; Koike, S.; Tanaka, N. J. Nat. Cancer Inst.; 53: No. 2, 517-525(Aug 1974).

Single radiation dose to yield 50% tumor control (TCD50) of various sizes of C3H mouse mammary carcinoma was examined. Tumor cell sensitivity to single radiation by x-ray or neutrons was determined by endpoint dilution, and the number of tumor cells in the tumor was determined by a count of tumor cell nuclei. A mathematical analysis of tumor control probability was made from these results; a formula was proposed which accounted for cell population kinetics or division probability model, cell sensitivity to radiation, and number of tumor cells. Analysis of regrowth probability of tumors irradiated with a single x ray indicated that tumors recurring after TCD50 might develop rapid regrowth after a long growth lag or a long period of slow growth, but the probability of cell division was reduced. (auth)

**20058** THERAPEUTIC EFFECT OF GALLATES ON SURVIVAL RATE AND PERIPHERAL BLOOD-PICTURE OF WHOLE-BODY X-IRRADIATED RATS. Bollman, G.; Schuenzel, G.; Mueller, G.; Schmidt, W.; Nehler, U.; Knak, J.; Homborg, P. (Biologischen Institut, Magdeburg, Ger.). Radiobiol.-Radiother.; 15: No. 5, 639-644(1974). (In German).

The therapeutic effect of sodium and propyl gallate on radiation injured leukogenesis and the survival of nearly lethally irradiated rats was investigated. Sodium gallate was uneffective under our experimental conditions. Propyl gallate reduced the radiation-induced general features (diarrhea, hemorrhages, behavior) of the animals, accelerated their leukogenesis in the phase of recovery and brought about a highly significant increase of survival rate. On the 30th day this was about 35% above the rate of the controls. The possible causes of the failing therapeutic effect of sodium gallate and of the positive effect of propyl gallate are discussed. (auth)

**20059** INHIBITION BY TESTOSTERONE OF IMMUNE REACTIVITY AND OF LYMPHOID REGENERATION IN IRRADIATED AND MARROW RECONSTITUTED MICE. Kotani, M.; Nawa, Y.; Fujii, H. (Kumamoto Univ. Medical School, Japan). Experientia; 30: No. 11, 1343-1345(15 Nov 1974).

Mice were given 850 rad whole body gamma radiation and injected with syngeneic bone marrow cells. Some mice were given testosterone and all animals received sheep red blood cells; all were killed 5 days later. The following results were observed in the testosterone-treated animals: reduction in thymus and spleen weight; decrease in plaque-forming cell count and rosette forming cell count; and fall in haemolysin titer. A severe depletion of lymphocytes occurred. (HLW)

**20060** MECHANISM OF ANTIBODY PRODUCTION AND THE EFFECT OF RADIATION. Medlin, J. (Ceskoslovenska Akademie Ved, Prague. Mikrobiologicky Ustav). Cesk. Fysiol.; 23: No. 1, 37-52(Mar 1974). (In Czech).

The effects of ionizing radiations on the production of antibodies are reviewed. The factors modifying the effect of radiation; the effect of radiation on the molecule of antibody and antigen; natural antibodies; primary and secondary reactions; immunological memory and immune tolerance and other aspects are considered. (INIS)

**20061** EFFECT OF SINGLE EXPOSURE TO IONIZING RADIATION ON THE CHONDROCRANIUM OF THE WISTAR RAT. I. Rajtova, V. (Department of Normal Anatomy, College of Veterinary Medicine, Kosice (Czechoslovakia)); Horak, J. (Department of General Biology, Faculty of Science, Safarik University, Kosice (Czechoslovakia)). Folia Morphol. (Prague); 22: No. 2, 181-187(1974).

The effect of 250 R of x radiation applied in a single exposure on the development of the nasal capsule in fetuses of Wistar rats was studied. Gravid female rats were irradiated on the 12th, 13th, 14th, or 15th day of pregnancy. They were sacrificed on the 19th day. The maximum changes in the chondrocranium of the fetuses were found in fetuses irradiated in utero on the 13th day. They included degenerative processes and defects in the nasal wall and the septum, in the turbinate primordia and the lamina cribrosa. The changes observed in fetuses irradiated on the 12th and the 14th days were much smaller; the findings in the fetuses irradiated on the 15th day differed little from the controls. (INIS)

**20062** THE EFFECT OF DIANABOL ON CERTAIN CELL ENERGY PROCESSES IN POSTIRRADIATION DISEASE. Sierakowski, S.; Panek, R.; Mackowiak, J. (Akademia Medyczna, Bialystok (Poland). Zaklad Farmakologii). Strahlentherapie; 148: No. 2, 168-172(Aug 1974).

It was found that Dianabol given to rats for 20 days brought about an increase in the level of lactate and a simultaneous decrease of liver pyruvate, which in consequence led to a diminished cellular redox potential. Dianabol, too, enhanced the activity of succinic acid dehydrogenase, and reduced that of cytochrome oxydase. These data indicate that long term administration of Dianabol may alter the cell metabolism towards more oxygen-independent pathway and they correspond with previously reported findings where the suggestion was put forward that Dianabol induced a tissue metabolic hypoxia. A concept that seems to be of importance, dealing with the radioprotective effects of Dianabol and concerning its action on the metabolic processes by diminishing the redox potential was advanced. (auth)

**20063** CHANGE IN SERUM PROTEINS AFTER PROLONGED IRRADIATION AND TREATMENT WITH LEUKOCYTIN. Tukhtayev, T. M. Tr. Tadzh. Gos. Med. Inst.; No. 97, 125-131(1972). (In Russian).

Rats were subjected to whole-body x irradiation at a total dose of 450 R (dose rate 2 R/min) and the total protein (P) concentration and blood protein fractions were determined over a 30-day period. Irradiation (I) was found to lower the P content on days 3 and 7. This was followed by a gradual restoration beginning day 12 and return to normal values on day 30 after I. Similar changes were noted in the content of albumins: the content of $\alpha_1$- and $\alpha_2$-albumin scarcely changed, finally decreasing only on day 30. The quantity of $\beta$-globulins rose sharply after I and returned to normal by the end of the observation period (30 days), but the concentration of $\gamma$-globulins decreased after days 7 and 12 and then returned to normal. The peroral administration of leukocytin (2 mg/kg every other day for 21 days after I) to the animals resulted in less pronounced changes in the P content. The amount of albumins at the height of acute radiation sickness did not decrease, in fact it increased slightly. The content of $\alpha_1$ and $\alpha_2$-globulins decreased sharply shortly after I while the $\beta$-globulins remained within normal limits and increased at the end of the experiment. The content of $\gamma$-globulins in the treated animals decreased less than in the irradiated rats that did not receive leukocytin. (Ref. Zh)

**20064** REACTION OF THE MESENTERIC MICROVESSELS TO EPINEPHRINE AFTER IONIZING RADIATION. Arav, I. I. Tr. Tadzh. Gos. Med. Inst.; No. 97, 27-30(1972). (In Russian).

In male rats with an exteriorized intestinal loop from the mesentery, changes were studied in the response of mesenteric microvessels to epinephrine (I) after local irradiation. Some 30 sec after application of 0.15 ml of the I solution (diluted 1 : 100,000), the average diameter of the mesenteric arteries and veins was 76 to 86 and 82 to 94% of the baseline. After 5 min of beta radiation ($^{90}$Sr, 1030 rads), the arterioles and precapillaries reacted strongly to I, but the vasoconstrictive effect of I on the true capillaries and venules scarcely changed. (Ref. Zh.)

**20065** RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF 30 MeV ELECTRONS AT VARYING DEPTHS IN TISSUE. Huang, D. P.; Mauldon, G. F.; Shen, C. M.; Ho, J. H. C. (Queen Elizabeth Hospital, Kowloon, Hong Kong). Brit. J. Radiol.; No. 563, 795-799(Nov 1974).

Using the stunting of vertebral growth of one-week-old inbred WHT/Ht mice as the biological test material and Fricke's ferrous sulphate method for dose measurements, the biological effectiveness of 30-MeV electrons relative to 250 kVp x rays was found to be in the region of 0.82. No difference of statistical significance was observed in the RBE of 30-MeV electrons given as single doses of 500 and 750 rads at per cent depth-dose levels varying from 100 to 10 in the case of the former and 100 to 15 in the case of the latter. (auth)

**20066** CHANGES IN CEREBRAL CHOLINE ACETYLTRANSFERASE AND ACETYLCHOLINESTERASE AFTER EXPOSURE TO COBALT-60 GAMMA-RAYS IN ASSOCIATION WITH SOME DRUG TREATMENTS. Pausescu, E.; Teodosiu, T.; Duducgian, M.; Muntiu, M. (Clinical Hospital Fundeni, Bucharest (Romania). Dept. of Experimental Pathology and Radiobiology). Strahlentherapie; 148: No. 2, 203-210(Aug 1974).

The activities of cerebral choline acetyltransferase (ChAc) and acetylcholinesterase (AChE) were investigated in lethally gamma-irradiated rats treated with cystamine, AET, a pyridine derivative (complamin) or alpha-methyl-DOPA. The patterns of response to gamma rays were obviously dependent on the drugs: cystamine and complamin were found to induce a similarly marked increase in radioresistance; AET was considerably less effective in increasing the radioresistance than cystamine and complamin, whereas alpha-methyl-DOPA was found to have an opposite effect. The results of the activity determinations of cerebral ChAc and AChE suggested a close relationship of the drug-induced radioresistance or radiosensitivity with the alterations of these enzymes. Thus, cystamine and complamin resulted in preventing the radiation-induced intracerebral accumulation of acetylcholine (ACh) through a markedly adverse action on cerebral AChE developed in both normal and irradiated rats; AET induced a reversal of the radiation-elicited inhibition of cerebral AChE and ChAc, but it did not act on these enzymes in normal rats, while alpha-methyl-DOPA was found to potentiate the effects of gamma-rays on these enzymes. Relationships of these events with the chemical biofunctional groups of the drugs and with their effects on cerebral biogenic amines may be stated. (auth)

**20067** RADIATION EFFECTS ON PIG SKIN. Exposure to Different Densities of Ionization. Lippincott, S. W.; Wilson, J. D.; Montour, J. L. (Virginia Commonwealth Univ., Richmond). Arch. Pathol.; 99: No. 2, 105-110(Feb 1975).

The effects on pig skin from radiations producing different densities of ionization have been determined. For the qualities of radiation employed, erythema was produced at a dose range from 1,240 to 3,440 rads and ulceration at 1,250 to 5,000 rads. In no instance did a radiation-induced neoplasm develop. In determining dose response, two of the most important physical parameters, associated with time of appearance and extent of lesions, were found to be the size of the area irradiated and the density of ionization of the radiations used. These data, on normal tissue tolerance, should be of value in future programs initiated in experimental radiation therapy of both animal and human neoplasia utilizing protons, $\alpha$ particles, and carbon ions. (auth)

## *Invertebrates*

**20068** REPAIR OF X-IRRADIATION DAMAGE IN TRIBOLIUM CASTANEUM STRAINS SELECTED FOR DIFFERENCES IN DEVELOPMENTAL RATES. Soliman, M. H. (Univ. of Alberta, Edmonton). Genetics; 78: No. 3, 897-904(Nov 1974).

Lines previously selected for different speed of development were found to differ in their spontaneous and induced wing abnormalities after single exposure to x-ray (10 kR) in Tribolium castaneum at 33°C and 70% relative humidity. At the time of irradiation the mean developmental time (from egg to first day pupa) was 16.9, 18.8, 22.8 and 18.4 days for fast, intermediate, slow and unselected lines, respectively. There was no difference

between males and females in their responses. The spontaneous rate (angular values) of wing abnormalities was 5.3%, 11.2%, 3.5% and 7.2%, and the corresponding induced values were 16.7%, 20.5%, 11.7% and 25.2% for fast, intermediate, slow and unselected lines, respectively. The difference between the spontaneous (due to selection) and the induced (due to selection and irradiation) rates indicates that slowing down development will probably increase the efficiency of the repair of the irradiation damage. This difference (angular values) was 11.4%, 9.4% and 8.1% for fast, intermediate and slow lines, respectively. Increasing developmental time by one day resulted in repairing 0.56% of the radiation damage. These results indicate that both the genetic and the developmental state of the line influence both induction and repair of the x-irradiation damage. The relationship between development, cell cycle, protein synthesis, and repair is discussed. (auth)

**20069** X-RAY INDUCED CHROMOSOMAL TRANSLOCATIONS WITH REFERENCE TO GENETIC CONTROL OF THE MOSQUITO ANOPHELES ALBIMANUS WIEDEMANN. Mohammad Rabbani, G. Urbana, IL; Univ. of Illinois (1974). 69p. University Microfilms Order No. 75-408.

Thesis (Ph. D.).

The presence of good quality salivary gland chromosomes in Anopheles albimanus facilitated the detection of radiation induced chromosomal translocations and location of the breakpoints to definite regions of the salivary chromosomes. Translocations involving all three chromosomes have been isolated and studied. Of particular interest have been the Y-autosome translocations because of the prospects of using such translocations in the genetic control of this important vector species of human malaria in Central and South America. In this context, the usefulness of one of the Y-autosome translocations, namely T(Y;2R)1, has been investigated in some detail. The males of this translocation strain have been found to be equally as competitive as the wild type males in sexual vigor. Cage release experiments with T(Y;2R)1 males in a ratio of 1:5 in favor of the translocation males for five successive generations have produced results which have shown that the translocation was incorporated into the cage population resulting in a highly significant reduction in the average hatching percentage of the eggs and thereby a definite decrease in the population density. In view of the recent sterile male release studies done by the U.S. Department of Agriculture and Central America Malaria Research Station in the region of Lake Apastepeque, El Salvador and the availability of the population dynamics data of Anopheles albimanus population of that area, a similar study project using translocation males toward genetic control of this species has been proposed. Such a study may produce valuable data bearing on the comparative efficiency of sterile male and translocation male methods in genetic control of Anopheles albimanus. (Diss. Abstr. Int., B)

**20070** COMPARATIVE STUDIES ON THE EFFECT OF REFRIGERATION AND CERTAIN RADIATIONS ON INFECTIVE HAEMONCHUS LARVAE OF DIFFERENT GENOTYPES. Daskalov, P.; Mutafova, T. (Tsentralna Khelmintologichna Lab., Sofia). Izv. Tsent. Khelmintol. Lab., Bulg. Akad. Nauk.; 15: 69-80(1972). (In Bulgarian).

After exposure to gamma rays up to 50,000 R, the larvae do not manifest changes in their external appearance and in their behavior from those of untreated larvae. In uv lamp radiation some of the larvae lose their motility and straighten out, while in those getting in 14 min of radiation, there are no mobile ones. Following a single or double refrigeration in water at 3 to −10°C for 24 and 48 hours and after subsequent thawing the larvae do not show any differences in their external appearance and in their behavior as compared with non-refrigerated ones. In the inoculated lambs, the gamma-treated larvae usually mature to adult specimens, but the female ones in particular, show monstrosities and other anomalies of the sexual system. The conclusion is drawn from the similar ratio between the three morphological types of females in the treated and control groups that the larvae of separate genotype do not manifest the differences in their resistance towards the treatments mentioned above and that the factors tested do not give rise to massive direct or reverse mutations of some of the genes that determine the morphological variation under discussion. Larvae that survived the treatments and matured to normal adult specimens brought forth a normal progeny. (auth)

# Radionuclide Effects (Internal Source)

## Man

*Refer also to abstracts 19547, 19549, 19550, 19561, 19676, 19938–19940, 19951, 19953, 19969, 19971, 19975, 19982, 19985, 19988, 19993, 19995, 20004, 20006, 20039, 20150, 21883, 21887, and 21893.*

**20071** (CONF-750109-7) CUEX METHODOLOGY FOR ASSESSING RADIOLOGICAL IMPACTS IN THE CONTEXT OF ICRP. Rohwer, P. S.; Kaye, S. V.; Struxness, E. G. (Oak Ridge National Lab., Tenn. (USA)). 1975. 25p. Dep. NTIS $4.25.

From 4th IAEA panel on peaceful nuclear explosives; Vienna, Austria (20 Jan 1975).

The Cumulative Exposure Index (CUEX) methodology was developed to estimate and assess, in the context of International Commission on Radiological Protection (ICRP) recommendations, the total radiation dose to man due to environmental releases of radioactivity from nuclear applications. Each CUEX, a time-integrated radionuclide concentration (e.g., $\mu$Ci-hr/cm$^3$), reflects the selected annual dose limit for the reference organ and the estimated total dose to that organ via all exposure modes for a specific exposure situation. To assess the radiological significance of an environmental release of radioactivity, calculated or measured radionuclide concentrations in a suitable environmental sampling medium are compared with CUEXs determined for that medium under comparable conditions. The models and computer codes used in the CUEX methodology to predict environmental transport and to estimate radiation dose have been thoroughly tested. These models and codes are identified and described briefly. Calculation of a CUEX is shown step by step. An application of the methodology to a hypothetical atmospheric release involving four radionuclides illustrates use of the CUEX computer code to assess the radiological significance of a release, and to determine the relative importance (i.e., percentage of the estimated total dose contributed) of each radionuclide and each mode of exposure. The data requirements of the system are shown to be extensive, but, not excessive in view of the assessments and analyses provided by the CUEX code. (auth)

**20072** (HEDL-SA-761) MATHEMATICAL ASPECTS OF THE YEAR 2000 RADIOLOGICAL STUDY. Dotson, W. L.; Fletcher, J. F. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1974. 18p. Dep. NTIS $4.00.

The Year 2000 Radiological Study, a series of regional evaluations of radiological dose from nuclear facility operation, is based on a series of complex, interlinked computer codes designated as the HERMES model. These codes are used to model the release, environmental transport, biological uptake, and resulting radiological dose to regional populations which result from operation of large numbers of nuclear facilities within a region. Characteristics of these computer codes, and their application to specific regional studies, are described. (auth)

**20073** (ORNL-5003) INREM: A FORTRAN CODE WHICH IMPLEMENTS ICRP 2 MODELS OF INTERNAL RADIATION DOSE TO MAN. Killough, G. G.; Rohwer, P. S.; Turner, W. D. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. 141p. Dep. NTIS $5.45.

INREM is a FORTRAN IV computer code to estimate the cumulative dose equivalents to body organs of man following a continuous intake, through inhalation or ingestion, of one or more radionuclides. Dosimetry parameters for the organs are dependent on the age of the individual, and the intake rate is a function of time and the individual's age. The method of estimation is based on adaptations of models presented in Publication 2 of the International Commission on Radiological Protection. The equations for the models are derived, and information about the code and its use is provided. (auth)

**20074** (ORNL-TM-4687) AIRDOS: A COMPUTER CODE FOR ESTIMATING POPULATION AND INDIVIDUAL DOSES RESULTING FROM ATMOSPHERIC RELEASES OF RADIONUCLIDES FROM NUCLEAR FACILITIES. Moore, R. E. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 82p. Dep. NTIS $7.25.

AIRDOS, a Fortran IV computer code, was written to estimate population and individual doses resulting from the continuous simultaneous atmospheric release of as many as 36 radionuclides from a nuclear facility. This report presents details of the code and complete instructions for its use. Five pathways to man considered include: inhalation of air containing radionuclide gases or particulates; immersion in contaminated air; exposure to surfaces contaminated by radioactive fallout; ingestion of food produced on contaminated ground surfaces; and immersion in contaminated water, as by swimming. Dose and dose commitments are estimated for each pathway and the following eleven reference organs: whole body, GI tract, bone, thyroid, lungs, muscle, kidneys, liver, spleen, testes, and ovaries. The environmental model in AIRDOS consists of a 20 × 20 square grid with the nuclear facility located at the center. The size of each grid is specified in the input data. Human population, numbers of beef and dairy cattle, and identification as to whether an area is predominately used for production of vegetable crops or is a water area are specified for each of the 400 grids. Population doses are summarized in output tables by nu-

clides, pathways, and organs. The highest individual dose received in the area and its location are printed in the output. (auth)

**20075** TOXICITY OF PLUTONIUM. Radiol. Prot. Bull.; No. 9, 5(Oct 1974).

The range of definitions of the concept of toxicity makes it difficult to assess materials with properties as different as those of lead, cadmium, beryllium, plutonium-239, iodine-131, and tritium on any one scale of toxicity. If the values of the maximum permissible concentrations for workers are compared, $^{131}I$ is shown to be over 400 times more toxic than $^{239}Pu$ in terms of mass. Tritium, a potential fuel for the fusion process, is about 200 times more toxic than soluble $^{239}Pu$ for chronic intake by ingestion, but the situation is reversed for chronic intake by inhalation, when soluble $^{239}Pu$ is 16 times more toxic than tritium (as the oxide). It is not therefore meaningful to describe $^{239}Pu$ as "the most toxic material known to man." (UK)

**20076** RADIUM IN MAN. Evans, R. D. Health Phys.; 27: No. 5, 497-510(Nov 1974).

From symposium on radiation protection at the 35th annual meeting of the American radium society; Boulder, CO (22 Apr 1973).

At sufficiently large dosages, chronic $\alpha$-radiation from skeletally deposited radium and mesothorium in humans results in osteoporosis, dense bone necrosis, spontaneous fractures, bone sarcomas, and carcinomas of the paranasal sinuses and mastoids. At high dose rates and high cumulative dosages (1,000 to 50,000 rads) the occurrence of radiogenic malignancy appears to be roughly independent of dosage, but the tumor appearance time seems to be longer for the lower doses than for the larger doses. Possibly a low dose domain exists in which the tumor appearance time exceeds the life span that remains after exposure. At cumulative dosages below the order of 1000 skeletal average rads no clinically significant radiobiological injury has yet been observed in the M.I.T. series over a time span of 40 to 50 yr in more than 500 persons. It may be that in the low-dose domain the rate of radiation injury is slower than the body's recovery and repair rates. The dosage vs response relationships for bone sarcoma and head carcinomas appear to be curvilinear and cannot be fitted to any known linear nonthreshold model. Linear extrapolations into the occupational dosage domain of a few rads can be made only with reservations and explicitly stated assumptions, and with recognition that the true value probably lies between the linear extrapolation value and zero. In constructing dosage vs response relationships it is imperative to recall that many contemporary tabulations of data, including present CHR, BEIR, and UNSCEAR tables, do not distinguish between unselected epidemiologically suitable cases and symptom-selected epidemiologically unsuitable cases. Use of these gross mixtures of unselected and selected cases has introduced significant bias into several recently proposed dosage vs response relationships. (auth)

**20077** MEASUREMENTS OF RADON UNDER VARIOUS WORKING CONDITIONS IN THE EXPLORATIVE MINING OF URANIUM. Kristan, J. (Jozef Stefan Inst., Ljubljana, Yugoslavia); Kobal, I.; Legat, F. pp 217-223 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

In the northwestern part of Yugoslavia lies a uranium ore deposit. To determine the dimensions of the strata and explore the geological structure of the ore deposit, mining and drilling operation were initiated. About 30 miners are working in this operation. Results are given of the radiological survey of the quality of the air in the mine and the cumulative annual inhalation doses of workers. The influence of the mine and mill waste waters on the environment and on the radiological status of the affected waters is given. (auth)

**20078** POPULATION DOSES RESULTING FROM RADIONUCLIDES OF WORLDWIDE DISTRIBUTION. Beninson, D. (National Atomic Energy Commission, Buenos Aires). pp 227-233 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

A simple methodology for calculating collective dose commitments is presented, together with estimates of the collective dose resulting from the worldwide distribution of radionuclides produced in the fuel cycle of nuclear power generation. It appears that the contribution of this global distribution to the collective dose commitment is in the order of a few tenths of a man·rem per MW·a. An example is presented on the use of the collective dose commitment concept to assess the cumulative effect in the future of the growing nuclear power generation. (auth)

**20079** POPULATION DOSE CONSIDERATIONS FOR THE RELEASE OF TRITIUM, NOBLE GASES, AND $^{131}I$ IN A SPECIAL REGION. Bayer, A.; Krishnamurthi, T. N.; Schueckler, M. (Institut fuer Neutronenphysik und Reaktortechnik, Karlsruhe, Ger.). pp 235-259 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Radiation exposure and risk to the population of the Upper Rhine river basin resulting from the operation of nuclear facilities are analyzed. The study-year is chosen as 1985, by which time an aggregate nuclear generating capacity of 40,000 MW(e) is planned to be installed in this region. Tritium, noble gases and iodine-131, being the main contributors to the radiological burden, are considered as the critical isotopes. Both atmospheric and hydrospheric transport paths of the nuclides are investigated in the study. Isopleths of whole body, lung, gonad, skin and thyroid doses are shown. Population dose and the resulting risk for certain radiation induced diseases are estimated and compared with natural incidence of the diseases. (auth)

**20080** CANADIAN EXPERIENCE IN ASSESSING POPULATION EXPOSURES FROM CANDU REACTORS. Das Gupta, A. K.; Taniguchi, H.; Measures, M. P. (Dept. of National Health and Welfare, Ottawa). pp 261-273 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The Department of National Health and Welfare has carried out a programme of environmental radioactivity surveillance around nuclear reactors since 1961 to assess the effect of low levels of radioactivity releases on public health. This has been in co-operation with the department of health of the province in which the reactors are located and includes the research reactors on the Ottawa River and the Winnipeg River, the Nuclear Power Demonstration station on the Ottawa River, the prototype generating stations at Douglas Point, Ontario and Gentilly, Quebec and the 4-unit, 2000 MW(e) station at Pickering, Ontario. These reactors are of the Canada Deuterium Uranium (CANDU) type, using natural uranium dioxide as fuel, heavy water as moderator and pressure tubes in the heat transport system. The features of this type of reactor which minimize potential releases of radioactivity to the environment are briefly discussed. The surveillance programme includes measurement of external radiation from gaseous effluents, tritiated atmospheric water vapour, radioactivity on airborne particulate matter, and in milk, water and biota from reactor environs. The current levels of these are presented. Estimates are made of the radiation dose being received by a hypothetical individual at the station boundary and is compared with the contribution from radioactive fall-out and natural background. It is shown that the CANDU reactors are capable of being operated reliably such that the resulting radiation dose to the population living in the vicinity is a few per cent of the natural radiation background. (auth)

**20081** GENETICALLY SIGNIFICANT DOSE FROM THE USE OF RADIOPHARMACEUTICALS. Roedler, H. D. (Freie Univ., Berlin); Kaul, A.; Hinz, G.; Pietzsch, W.; Stieve, F. E. pp 377-393 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

To estimate the genetically significant dose (GSD) from the use of radiopharmaceuticals, a survey of the applications of radionuclides in nuclear medicine in Berlin (West) was performed for the years 1953–1970. In addition, the values of gonad doses were recalculated on the basis of the unitarily demonstrated biokinetic data and the recently extended dose concept of absorbed fractions. The recalculations proved to be necessary since an extensive compilation of published absorbed doses had yielded variations of up to a factor of 100. This is due to the incompleteness and uncertainty of biokinetic data and the choice of

different biokinetic models and mathematical methods for absorbed dose calculation. The GSD from the use of radiopharmaceuticals proved to be 0.2 mrad for 1970. It does not change significantly if conventional radionuclides are replaced by short-lived radionuclides or pure gamma emitters aimed at critical organ dose reduction. Even if the present 20% yearly increase in the number of applications of radiopharmaceuticals is supposed to remain constant in the future, the contribution of diagnostic nuclear medicine to the total GSD will be small compared to that from the diagnostic use of x-rays. (auth)

**20082** CONSIDERATIONS IN ASSESSING THE POTENTIAL HARM TO POPULATIONS EXPOSED TO LOW LEVELS OF PLUTONIUM IN AIR. Bair, W. J. (Battelle Pacific Northwest Labs., Richland, WA). pp 435-449 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Results from experimental animal studies have provided extensive knowledge of the disposition and biological effects of plutonium. While these laboratory studies involved levels of plutonium much higher than the predicted dose commitments from nuclear power plant operation, the results of these experiments along with the limited data from accidental human exposures can provide a basis for preliminary assessment of the harm to populations from plutonium that might be released to the environment. Experimental animal studies have identified lung and bone cancer as the most sensitive effects of plutonium exposure. Drawing upon the results from experiments with several animal species and several plutonium compounds the possibility of deriving risk estimates for plutonium-induced lung cancer on a toxicological basis was explored, thus avoiding the need to consider the spatial distribution of absorbed radiation dose in lung, latent period for cancer induction, etc. Values for the risk of lung cancer resulting from inhaled plutonium average about $2 \times 10^{-4}$ per nCi/g lung · days for $^{239}$Pu. A value of $2 \times 10^{-3}$ was calculated for $^{238}$Pu from the results of one experiment with rats. (auth)

**20083** ASSESSMENT OF POTENTIAL HEALTH CONSEQUENCES OF TRANSURANIUM ELEMENTS. Barr, N. F. (Div. of Biomedical and Environmental Research, Washington, DC). pp 451-462 of Population Dose Evaluation and Standards for Man and His Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The results are presented of a study to provide quantitative estimates, per unit of electrical power generated, of potential consequences to human health from inhaled or ingested transuranium elements released during the generation of electricity by the liquid metal fast breeder reactor (LMFBR) fuel cycle. Soon after release direct inhalation of downward descending airborne particles is the dominant route of entry of transuranic elements into man. The fraction of material entering man in this way is estimated to be $4 \times 10^{-6}$. A comparable fraction enters man through inhalation of material resuspended into the atmosphere after deposition. Estimates for the fraction of released material that enters man through ingestion processes from the time of release to complete decay of the activity are made for the most significant radioisotopes of plutonium, americium and curium. $^{241}$Am is the largest contributor to dose by this pathway. Health effects estimates based on current metabolic data, ICRP dose models and the report of the committee on Biological Effects of Ionizing Radiation of the US National Academy of Sciences, when combined with these pathway analyses, indicate that there are unlikely to be more than about $10^{-3}$ potential health effects for each 1000 megawatt electric year of power generated. (auth)

**20084** UK EXPERIENCE ON THE MEDICAL ASPECTS OF RADIOLOGICAL PROTECTION OF WORKERS HANDLING PLUTONIUM. Schofield, G. B.; Dolphin, G. W. (British Nuclear Fuels Ltd., Windscale, Eng.). Ann. Occup. Hyg.; 17: No. 2, 73-83(Dec 1974).

The radiological problems in the protection of workers handling plutonium are discussed and some data obtained at autopsy are given as well as health statistics of the workers at Windscale. This is preceded by a short account of the physical and biological properties of plutonium. (auth)

**20085** RADIONUCLIDES AND BONE: FROM $^{226}$Ra TO $^{90}$Sr. Spiers, F. W. (Univ. of Leeds, Eng.). Brit. J. Radiol.; 47: No. 564-844(Dec 1974).

From Silvanus Thompson memorial lecture; London, Eng. (17 May 1973).

Consideration was given to the toxicity of $^{226}$Ra and $^{90}$Sr and to the need for dosimetry that is relevant to the possibility of tumour induction by these radionuclides. The tissues at risk from bone seekers are identified and new methods are given of determining the absorbed dose in bone marrow and endosteal tissues. The calculations of energy deposition were based on measured distributions of path lengths through trabeculae and marrow spaces and were thus linked directly to the structure of individual bones. Results are given for various $\beta$ emitters and for $^{226}$Ra $\alpha$ particles in both human and animal bone. They are considered in relation to radiobiology, radiation protection, and the dose to infant bone from fallout $^{90}$Sr. Bone structure affected the magnitude of the dose from any incorporated radionuclide and differences in structure must be taken into account in translating the results of toxicity studies in animals to man. (auth)

**20086** MENSTRUAL FUNCTION IN OPERATORS DEALING WITH PHOTOCOMPOUNDS OF PERMANENT ACTION. Muratova, R. M. (Inst. of Hygiene and Prophylaxis, Erevan). Med. Radiol.; 20: No. 2, 22-26(Feb 1975). (In Russian).

The author treats of the problem of the menstrual function of 100 women engaged in production and use of luminous dyestuffs containing radium bromide, zink sulfide, a small amount of potassium or ammonium sulfate. During operation the women-workers were subjected to combined action at the expense of external $J$-radiation (from 10 to 500 bar) and possible advent of the mentioned chemical compounds and products of their division in the organism. Frequency of disorders of the menstrual function in the examined women was higher than in persons of the control group, the nature of disorders was more often of a hypooligoopsomenorrhea type. The menstrual function disorders appeared already with a small service record and were more marked in women engaged in the production of photocompounds than in persons engaged in the use of luminous dyestuffs (in women of this group such disorders developed more often with the service record above 10 years). (auth)

## Animals

*Refer also to abstract 19591, 20017, 20046, 20099, and 20107.*

**20087** (AEC-tr-7602, pp 102-107) CELL COMPOSITION OF THE WALL OF THE PULMONARY ALVEOLI OF RATS AFTER A SINGLE INHALATION OF MONOMER AND POLYMER FORMS OF PLUTONIUM-239. Bukhtoyarova, Z. M.; Poplyko, M. G. 1974. Translated from Radiobiologiya; 14: No. 4, 555-558(1974).

In Radiobiology.

Plutonium-239 in monomer and polymer forms induces destructive changes in cells of the wall of the alveoli of the lungs, a sharp decrease in the number of endothelial cells and an increase in the alveolar cells and connective tissue cells. The indicated changes are directly associated with the development of subsequent, more long-term damages to the lungs (pneumosclerosis, tumors), the severity and periods of onset of which depend on the form and dose of the introduced plutonium. (auth)

**20088** (AEC-tr-7602, pp 121-125) SPECIES DIFFERENCES OF THE LIFETIME OF DOGS, RABBITS, AND RATS IN THE CASE OF INTERNAL IRRADIATION WITH $^{210}$Po. Parfenov, Yu. D. 1974. Translated from Radiobiologiya; 14: No. 4, 568-571(1974).

In Radiobiology.

The changes in the median lifetime of dogs, rabbits, and rats after subcutaneous injection of $^{210}$Po as a function of the absorbed dose by the time of death and of the initial absorbed dose rate in the organism can be characterized by four phases. Each phase has its own corresponding species relationships of radiosensitivity to internal irradiation with $^{210}$Po. (auth)

**20089** (AEC-tr-7602, pp 143-145) EXCRETION OF $\beta$-AMINOISOBUTYRIC ACID WITH THE URINE IN RATS INJURED BY STRONTIUM-90. Uspenskaya, M. S. 1974. Translated from Radiobiologiya; 14: No. 4, 583-585(1974).

In Radiobiology.

A solution of $^{90}$Sr chloride was administered to rats subcutaneously and urine was collected at intervals up to 28 days later. At a dose of 2 $\mu$Ci/kg, a sharp increase occurred in the excretion of $\beta$-aminoisobutyric acid after 1 to 13 days. At a dose of 4 $\mu$Ci/kg, an increased excretion occurred only on the first and 13th days. (HLW)

**20090** PLUTONIUM-INDUCED POPLITEAL LYMPHADENITIS IN BEAGLES. Dagle, G. E.; Phemister, R. D.; Lebel, J. L.; Jaenke, R.; Watters, R. L. (Colorado State Univ., Fort Collins). Radiat. Res.; 61: No. 2, 239-250(Feb 1975).

High-fired $^{239}$plutonium oxide particles injected into the hind paws of beagles accumulated in the popliteal lymph nodes. Histo-

pathologic changes in these lymph nodes were characterized primarily by reticular cell hyperplasia, increased numbers of macrophages, necrosis, and fibroplasia. Eventually the plutonium particles became sequestered by scar tissue that often replaced the normal architecture of the lymph node. Light-microscopic autoradiographs of the popliteal lymph nodes showed a time-related increase in number of alpha tracks per plutonium source. Electron microscopy showed that plutonium particles were aggregated in phagolysosomes of macrophages. (auth)

**20091** EFFECT OF β-IRRADIATION ON 3-METHYLCHOLANTHRENE INDUCTION OF BRAIN TUMORS IN MICE. Mandybur, T. I. (Univ. of Cincinnati). J. Nat. Cancer Inst.; 53: No. 2, 399-406(Aug 1974).

Localized radiation was delivered to the brains of C57BL mice by implanted β-ray-emitting tungsten wires. Mice were divided into 4 groups, given 1000, 2400, 3900, and 5000 rad, respectively; 3-methylcholanthrene (MCA) was then implanted into the irradiated brain. Control animals receiving only radiation had no tumors. When MCA implantation was preceded by β-radiation, tumor yield was inversely proportionate to the radiation dose. Irradiation apparently decreased the neoplastic response of the nervous tissue by reducing the number of cells available to be stimulated by MCA. The latent period of tumorigenesis and histologic types of neoplasms developing in irradiated brain tissue were comparable to those in a nonirradiated group into which MCA pellets were implanted at a similar location. (auth)

**20092** MORPHOLOGICAL EVALUATION OF $^{226}$Ra INDUCED OSTEOGENIC SARCOMA IN MICE. Holusa, R.; Kofranek, V.; Onyskowova, Z. (Inst. of Hygiene and Epidemiology, Prague). Neoplasma; 21: No. 6, 697-709(1974).

Two groups of random bred SPF female mice of H strain injected intraperitoneally with two doses of $^{226}$Ra activity (8.2 μCi/kg and 20 μCi/kg) were histologically examined and bone tumors as a specific effect of radionuclide incorporation were evaluated morphologically. In the group of 122 mice with lower activity, 20 bone tumors (19 osteosarcomas and one ossifying fibroma of mandibula) and in the group of 94 mice with the higher activity 17 osteosarcomas were determined. In the control group of 72 mice one spontaneous osteosarcoma was found. In the incidence there were no differences with regard to the injected activity. Most of the induced osteosarcomas were localized in the axial skeleton (59.4%). From the jaws arose six tumors. Morphological features of induced as well as spontaneous neoplasms were described and their behavior and differential diagnosis discussed. (auth)

### Plants

*Refer also to abstract 21929.*

## Nuclide Kinetics and Toxicology

### Man

*Refer also to abstracts 20075 and 20085.*

**20093** (DHEW/FDA-75-8010, pp 78-80) REPORT OF THE TASK FORCE ON RADIOPHARMACEUTICALS. Porter, B. J. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Proposed standards for the regulation of radiopharmaceuticals used in nuclear medicine are discussed. The role of the Federal Food and Drug Administration in the development of the standards is reviewed. (CH)

**20094** (DHEW/FDA-75-8010, pp 199-214) TRANSURANICS IN THE ENVIRONMENT: THE EPA PERSPECTIVE. Mills, W. A. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Problems encountered in assessing the hazards associated with the environmental contamination of transuranium elements, with the goal of setting applicable standards for environmental dose commitments for human populations are discussed. Plutonium-239 and $^{238}$Pu are the most frequently handled of the transuranium elements, and by the year 2000 the inventory of $^{239}$Pu will be increased due to content in new or spent fuel for fast breeder reactors and the inventory of $^{238}$Pu will be increased due to its use in SNAP power systems for space satellites. The transuranium elements are primarily α emitters and have long radioactive half-lives so that they will persist in the environment for extended periods of time and small quantities can move through the environment and potentially expose a large population. The need for radiation protection standards taking into consideration the long-term impact and the total releases is emphasized. (CH)

**20095** KINETICS OF $^{99m}$Tc-LABELED PYROPHOSPHATE AND POLYPHOSPHATE IN MAN. Krishnamurthy, G. T.; Huebotter, R. J.; Walsh, C. F.; Taylor, J. R.; Kehr, M. D.; Tubis, M.; Blahd, W. H. (Veterans Administration Wadsworth Hospital Center, Los Angeles). J. Nucl. Med.; 16: No. 2, 109-115(Feb 1975).

The kinetics of $^{99m}$Tc-labeled pyrophosphate were compared with those of polyphosphate in ten patients in a combined study. Both agents cleared from the blood in a biexponential fashion. The clearance half-time of Exponent I was the same for both and was shorter than the clearance half-time of Exponent II. Urinary excretion of both agents was the same during the first hour but during the next 3 hr Tc-pyrophosphate cleared at a slightly more rapid rate, resulting in lower blood background radioactivity. Both agents were bound loosely to plasma proteins, mainly to globulin fractions. The sensitivity of lesion detection was similar for both. Excellent bone images were obtained with both agents. The images with Tc-pyrophosphate were consistently superior owing to the low blood background and they took less time to accumulate an identical number of counts from identical regions. With the amount of $^{99m}$Tc-complex used, no hpyocalcemia or tetany was noted, nor was there any significant effect on 1-hr serum levels of inorganic phosphorus and alkaline phosphatase. Four hours after injection, 9.5% of the dose of Tc-pyrophosphate was circulating in blood, 31.7% was excreted in urine, and the remaining 58.8% was taken up by bone and other tissues. The corresponding values with Tc-polyphosphate were 12.5% in blood, 29.0% in urine, and 58.5% in bone and other tissues. Among the soft tissues, the genito-urinary system is most consistently visualized. It is concluded that both Tc-pyrophosphate and Tc-polyphosphate are excellent skeletal-imaging agents and that Tc-pyrophosphate appears slightly superior to Tc-polyphosphate. (auth)

**20096** RADIOECOLOGICAL IMPLICATIONS OF THE USE OF Na$^{131}$I IN CLINICAL MEDICINE. Favino, A.; Besseghini, G. F.; Ghittori, S. (Univ. Pavia, Italy). G. Fis. Sanit. Prot. Radiaz.; 18: No. 1-2, 1-8(1974). (In Italian).

About 200 Ci of Na$^{131}$I are presently used in Italy every year for thyroid function studies and for therapy. An evaluation is presented of the fractions of the radioiodine discharged from nuclear medicine units where $^{131}$I is administered for diagnostic and therapeutic purposes. Separate estimation is given of the fraction originated from decontamination of the glassware where radioiodine is administered and where in vitro tests are performed in the laboratory and of the fraction which is excreted from the patient submitted to diagnostic tests or to therapeutic treatments in the ward. Data are reported of the urinary excretion within 24 hours after administration of radioiodine and referred to subsequent 6 hours interval in 221 patients with different levels of thyroid function. Most of the activity is excreted in the first hours and excreted amounts are inversely proportional to the level of the thyroid function. Due to the fact that most of the radioactivity is coming from the patient and particularly from the treated subjects, the opportunity is stressed of the preliminary control of the urinary disposal from the ward. The original experience is described of a prototype system for storage and autodilution of the physiological waste with an automatic monitoring of the effluents. The device is useful for removing peaks of radioactive concentration from being discharged into the sewage system. A method is described for analytical survey of radioiodine into the sewage effluents by ionic exchange resins with a sensitivity of $5 \times 10^{-9}$ μCi/ml for $^{131}$I. Preliminary results are reported of the uptake of radioiodine in an in vitro experiment on a fodder-plant (Lupinus luteus). Data are discussed referring to the problem of control of the concentration of this radioactive pollutant in superficial waters. (auth)

**20097** HEALTH OF PLUTONIUM WORKERS. Schofield, G. B. (British Nuclear Fuels Ltd., Windscale, Eng.). Lancet; 2: No. 7894, 1456(14 Dec 1974).

Some aspects of the plutonium "hot particle" problem recently discussed in the editorial in the Lancet (23 November 1974, 7891 1238) are amplified. There are certainly no long term in vivo measurable amounts of plutonium in lung among exposed personnel in this country. A number of workers have experienced pulmonary intakes of plutonium of measurable proportions, but normal ciliary mechanisms rapidly reduced these intakes to amounts too low to be measured; the small residual quantities deliver doses far below the maximum permissible doses recommended by the ICRP. The measured particle size distribution

(2 to 10 μm A.D.) of airborne plutonium at Windscale would result in very little penetration into the deep lung, and the residence time of plutonium in the chests of exposed Windscale workers was comparatively short. An intensive medical follow-up of all Windscale workers has been in progress since 1950; examination of post-mortem material from 13 plutonium exposed workers revealed total body and organ contents of plutonium very much less than those calculated during the individual's lifetime, and in any case very much below the ICRP recommended maximum. Although treatment of over-exposed plutonium workers with DTPA (diethylene-triaminepenta-acetic acid) rapidly clears the blood of plutonium, plutonium deposited intracellularly cannot be removed by DTPA. Modification of DTPA so that it is able to remove intracellular plutonium would presumably have the concurrent disadvantage of conferring the ability to remove other intracellular trace metals. In the final analysis the plutonium production plant should be so designed and operated that the workers are not exposed by inhalation to significant quantities of plutonium. (UK)

## Animals

*Refer also to abstracts 19555, 19597, 20039, 20046, 20089, 20135, and 20136.*

**20098** INCREASE OF $^{226}Ra$ IN THE WATER INTAKE BY SHEEP. Khademi, B.; Mahdavi, A. (Teheran Univ., Iran). Health Phys.; 27: No. 5, 522-524(Nov 1974).

Concentrations in the range of $2.16 \times 10^3$ to $1 \times 10^4$ pCi/l of $^{226}Ra$ with a mean value of $5.4 \times 10^3$ pCi/l have been reported in spring and mineral water in the Ramsar region of the Caspian sea (Khademi, B. and Mesghali, A., Health Phys.; 21: 464 (1971)). Since the area is densely populated a study was undertaken of the possible uptake of $^{226}Ra$ by sheep in the area. Two sheep were kept under a high $^{226}Ra$ diet for 31 days and daily milk, urine and fecal samples taken. The results are tabulated. No definite conclusions could be drawn from the results. (UK)

**20099** EXCRETION AND ACUTE TOXICITY OF $^{239}PuO_2$ IN BABOONS. Metivier, H.; Nolibe, D.; Masse, R.; Lafuma, J. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Health Phys.; 27: No. 5, 512-514(Nov 1974).

Results of studies on the excretion rates and pathological findings in baboons that had inhaled plutonium dioxide are summarized. Each baboon inhaled from 24 to 600 nCi/g of fresh lung $^{239}PuO_2$ dust particles. Sixteen animals were measured; the fecal excretion was followed and the amount excreted added to the lung and pulmonary lymph node burdens at time of death in order to get an accurate result of whole body counting at $T_0$. The clearance curves were fitted into two exponential curves by least square analysis. Translocation of plutonium to organs other than pulmonary lymph nodes was found negligible in acute toxicity (less than 600 days). Twenty-three animals were sacrificed just before the predictable time of death and were used to determine the logarithmic relationship between survival times and lung deposits. The biological half-life and repartition of $^{239}PuO_2$ particles in the lung clearance in the animals are tabulated and the relationship between $^{239}PuO_2$ lung burden at death and survival time are graphed. It was shown that, as in man or dogs, excretion of the plutonium particles deposited in the deeper lung is slow. Pathological investigations show that baboons are much more sensitive than dogs to acute internal irradiation. (UK)

**20100** PHARMACOKINETICS OF RADIOIODINATED STREPTOKINASE. Coates, G.; DeNardo, S. J.; DeNardo, G. L.; Troy, F. A. (Univ. of California, Davis). J. Nucl. Med.; 16: No. 2, 136-142(Feb 1975).

The pharmacokinetics of radioiodinated streptokinase were investigated in mice and dogs in order to explore further its potential usefulness as a radiopharmaceutical to detect thrombi and neoplasms. The purified streptokinase used in these studies showed no alteration in its physical or enzymatic properties following radioiodination. In the mouse, radioiodinated streptokinase accumulated rapidly in the liver and at 4 hr, large amounts of free iodine were detected in the plasma. The plasma clearance curve in dogs was biexponential showing that 70% of the protein-bound radioactivity was cleared with a half-life of 15-25 min while the remaining 30% was cleared with a half-life of 60-80 min. Seventy percent of the plasma radioactivity appeared as free iodine after 4 hr. No change in clearance was obtained by preloading animals with unlabeled streptokinase. Based primarily on the rapid plasma clearance, deiodination, and possible limitations of effectiveness of preloading with unlabeled streptokinase, the results of these studies are in accord with the conclusion that radioiodinated streptokinase may have restricted usefulness as a radiopharmaceutical for detecting thrombi and neoplasms. The full extent of its potential usefulness, however, awaits the provision of further in vivo and in vitro studies directed at testing a covalently modified enzyme that retains streptokinase activity but whose immunologic properties have been altered so that the enzyme is not as rapidly cleared from the plasma. (auth)

**20101** INCORPORATION OF $^{125}I$-THYROXINE BY THE BRAIN OF THE FETAL AND NEONATAL RAT. Lane, A. Chicago; Univ. of Illinois (1973). 92p. University Microfilms Order No. 74-27,278.

Thesis (Ph. D.).

Fetal (19 day), neonatal (2 day) and postnatal (14 day) rats were injected IP with $^{125}I$-thyroxine and the rate of removal from the circulation and rates of loss by brain, liver, and placenta monitored. Direct scintillation counting, thin-layer chromatography and autoradiography were employed in this study. Placenta, liver, cerebrum, cerebellum, pons-medulla and mesdiencephalon have the capacity to accumulate radioactive hormone in the developing rat. As could be anticipated, placenta and liver concentrated the hormone to the greatest extent, followed by cerebrum, cerebellum, pons-medulla, and mes-diencephalon. The rate of turnover of labeled metabolites by the liver increased with age of the animal. The rate of loss of radioactivity by brain tissue was slower in fetal than postnatal animals. Autoradiographs demonstrate grains in choroid plexus, cerebrum, hypothalamic area and ventricular space, in that order of decreasing intensity. Both cerebrum and hypothalamic areas show a grain localization in the nuclei of neutrons exceeding grain concentration in cytoplasm. Chromatographic analysis demonstrated the following radioactive substances: $T_4$/DIT, $T_3$/MIT, free iodine and origin material. Origin material is probably bounded protein. This substance in brain and liver of all age groups exceeded blood levels at all time periods studied. Mes-diencephalon levels of free iodine exceeded those of the blood at most time periods. (Diss. Abstr. Int., B)

**20102** NATURAL $^{226}Ra$ AND $^{228}Th$ IN THYROIDS OF CATTLE FROM NIGERIA, W. AFRICA. Ekpechi, O. L. V.; Van Middlesworth, L.; Cole, G. (Univ. of Nigeria, Nsukka). Int. J. Nucl. Med. Biol.; 2: No. 1, 31-33(Jan 1975).

Two analyses of the gamma spectra, at intervals of 4 to 6 weeks, of samples of thyroid from 103 Nigerian cattle revealed that more than 80 per cent contained easily detectable quantities of $^{228}Th$, possibly mixed with $^{226}Ra$. Radioautographs of these thyroids showed highly concentrated sources of alpha particles distributed throughout the thyroid. Measurements of the alpha tracks suggested that each 6.5-MeV alpha particle produced 9000 rad along its track and many of these tracks traversed thyroid cells. These results contrast with the much lower published occurrences of $^{226}Ra$ and $^{228}Th$ in cattle in USA and Colombia. The bovine thyroid samples came from an area of Nigeria where both high levels of natural radioactivity and a high incidence of human goitre have been reported. The relationship between natural radioactivity and thyroid disease has yet to be established; however, this concentration of natural radium in the thyroid may be a contributory factor. (UK)

**20103** THYROID CONCENTRATION OF BARIUM AND RADIUM. Van Middlesworth, L.; Robison, W. L. (Univ. of Tennessee, Memphis). Int. J. Nucl. Med. Biol.; 2: No. 1, 1-4(Jan 1975).

Microscopic concretions of barium and sulfur, mixed with natural radium were observed within the follicles of bovine thyroids from widely separated parts of the world. At least 80 per cent of bovine thyroids received from Nigeria, West Africa, and 60 per cent of those studied from Colorado, contained the radioactive concretions; their incidence has been less in other areas. The concretions probably consist of barium sulfate mixed with radium but the mechanisms for incorporation of these elements into thyroid follicles are unexplained. These radioactive bodies cause adjacent thyroid follicular cells to be exposed to relatively intense alpha radiation, but as yet, no biological effects have been ascribed to this radiation. (auth)

**20104** ACCUMULATION FROM SEA WATER OF $^{65}Zn$, $^{54}Mn$, $^{58}Co$, AND $^{59}Fe$ BY THE THORNBACK RAY, RAJA CLAVATA L. Pentreath, R. J. (Fisheries Radiobiological Lab., Lowestoft, Eng.). J. Exp. Mar. Biol. Ecol.; 12: No. 3, 327-334(Sep 1973).

The accumulation of $^{65}Zn$ and $^{54}Mn$ in the tissues of R. clavata was studied and related to stable element concentrations. The accumulation of $^{58}Co$ and $^{59}Fe$ was also studied on a whole body basis and comparisons were made of the $^{59}Fe$ levels in the tissues after 84 d with those of the stable element. Lower values of accumulation were obtained than those found in the teleost Pleuronectes platessa. Such differences are discussed in relation to the relative permeabilities of the 2 species to seawater and the relative ratios of the radionuclides from seawater : blood plasma, and of blood plasma : organ. The direct input from seawater for both species plays only a minor role in the accumulation of the 4 radionuclides. (Pollut. Abstr.)

**20105** ACCUMULATION AND RETENTION OF $^{59}Fe$ AND $^{58}Co$ BY THE PLAICE, PLEURONECTES PLATESSA L. Pentreath, R. J. (Fisheries Radiobiological Lab., Lowestoft, Eng.). J. Exp. Mar. Biol. Ecol.; 12: No. 3, 315-326(Sep 1973).

The accumulation of $^{59}Fe$ and $^{58}Co$ from water by P. platessa was studied in tissues and their levels of accumulation related to stable element concentrations. The retention of both radionuclides from labeled Nereis and labeled pellets was also examined. Biological half-times of the exchange with water were calculated for many organs, although the rate of accumulation for some tissues could only be expressed as a linear function. For both radionuclides the direct accumulation from water resulted in concentration factors of <1% of the values inferred from the stable element data. The relevance of such observations to heavy metal pollution at the higher trophic levels is discussed. (Pollut. Abstr.)

**20106** OXATHIOL EFFECTS ON $^{210}Po$ RETENTION IN THE DOGS' ORGANS. Parfenov, Yu. D.; Konstantinova, T. P.; Altuchova, G. A.; Vlasov, P. A.; Ovdienko, N. I. (Ministerstvo Zdravookhraneniya SSSR, Moscow. Inst. Biofiziki). Strahlentherapie; 148: No. 2, 173-179(Aug 1974).

To remove $^{210}Po$ from the dogs' bodies after a single subcutaneous administration, oxathiol was used. As a result $^{210}Po$ retention in the lymphatic nodes, muscles, adrenals, and bones of the treated dogs is 0.1 to 0.4 and in the spleen and lungs 0.5 to 0.7 parts of the level in the organs of the untreated dogs. In early periods $^{210}Po$ concentration in the kidneys of treated animals is about 3 times higher than in the untreated ones. Oxathiol treatment does not exchange $^{210}Po$ distribution in the kidneys, but a certain increasing of $^{210}Po$ deposition was observed in the inner zone of the cortex adjacent to the medulla. (auth)

**20107** IN VIVO BEHAVIOR AND EFFECTS OF $^{85}Kr$ IN GUINEA PIGS. Kirk, W. P. II. Rochester, NY; Univ. of Rochester (1974). 277p. University Microfilms Order No. 75-1306.

Thesis (Ph. D.).

The radiation hazards associated with exposure to $^{85}Kr$ and specifically to that part of the hazards arising from isotope contained in the body are considered. Section I explains the organization and history of the thesis. Section II, titled "Krypton-85, A Review of the Literature and An Analysis of Radiation Hazards," was issued in January, 1972 by the Office of Research and Monitoring, EPA. This review summarized, as of early 1971, most of the existing information on $^{85}Kr$. Major subject areas are (1) physical, chemical, and radiological data, (2) maximum permissible concentration in air $(MPC)_a$ and its rationale, (3) source data, (4) atmospheric concentrations and dose estimates near fuel reprocessing facilities and world-wide, (5) proposed control methods, (6) uses in science and industry, (7) calculations of dose to various organs and their relationship to the $(MPC)_a$, (8) unexplained noble gas phenomena, and (9) methods of sampling and analysis. The theory of absorption of $^{85}Kr$ into the body, and the rates thereof, are discussed in Appendix A to this section and again, in more detail, in Section III. Section III, titled "Physiological Behavior and Radiation Effects of $^{85}Kr$ Administered to Guinea Pigs via the Respiratory Route," presents the original research conducted which attempted to determine, for guinea pigs breathing a known concentration of $^{85}Kr$ under one set of conditions, how much isotope was absorbed into the body, its rate of absorption and desorption, its detailed distribution at equilibrium, and whether its effects would be comparable to exposure to x- or gamma radiation at comparable delivered doses to the critical organs. The whole-body behavior of $^{85}Kr$ was investigated by counting the radiation emitted from guinea pigs breathing an $^{85}Kr$-air mixture. Animals were counted during saturation until equilibrium was reached when the animals were permitted to breath uncontaminated air while counting continued until preexposure background was reached. Saturation and desaturation curves were multiple-exponential in form and usually had four components with half-times of 0.25 to 2.2 minutes, 6 to 12 minutes, 21 to 42 minutes, and 88 to 178 minutes. The whole-body weight partition coefficient was determined, concurrently with the kinetics studies, to be 0.1444 ($\sigma = 0.0148$). Weight partition coefficients were determined in vivo in guinea pigs for blood and 22 other organs and tissues using a dual-isotope technique that permits simultaneous determinations for the whole and bloodless tissue. The highest coefficients found were: omental fat (0.4213); subcutaneous fat (0.4054); thymus (0.2588); lymph nodes (0.1375); bone marrow (0.1342); and adrenals (0.1071). The in vivo coefficients generally agreed well with predictions based on in vitro solubility determinations and the fat-protein-water composition of the tissue reported in the literature. Guinea pigs were exposed via the respiratory tract for 12 hours to $^{85}Kr$ concentrations ranging from 54 to 520 $\mu Ci/cm^3$ and observed for 60 days or until death, whichever occurred first. The 30-day median lethal exposure was 4450 $(\mu Ci/cm^3)$hr which corresponds to estimated doses of 316 rads to the bone marrow, 340 rads to the whole body, and 7876 rads to the lungs. The marrow and whole-body doses, times of death, and the gross clinical and necropsy observations were consistent with death by the hematopoietic syndrome but lung injury was evident at all higher exposures and was the dominant injury in animals that survived for more than 30 days. The whole body and marrow doses delivered at the median lethal exposure and the observed times of death are similar to those reported in x- or gamma radiation lethality studies. Section IV data and graphs from the experiments summarized in Section III which were too voluminous or repetitious to include in a paper intended for direct publication are considered. (Diss. Abstr. Int., B)

### *Plants*

*Refer also to abstracts 19216, 19560, 19596, and 19606.*

**20108** (INIS-mf-1604) SEASONAL CHANGES IN $^{131}I$ UPTAKE BY PEA CV. PYRAM. Liptakova, G. (Univerzita P. J. Safarika, Kosice (Czechoslovakia). Katedra Vseobecnej Biologie; Univerzita P. J. Safarika, Kosice (Czechoslovakia). Radiobiologicke Lab.). Jun 1973. 4p. (In Slovak). INIS.

2 parts in one volume, each containing various partial reports.

In experiments aimed at elaborating methods of measuring radioactivity, preparing samples, and washing out radioactive roots, a decrease in $^{131}I$ uptake by pea samples was observed at a certain time of the year. The cause could not so far be satisfactorily explained. (INIS)

## New Tracer Techniques

*Refer also to abstracts 19196, 19223, 19327, 19349, 19366, 19612, 19668, 19993, 19995, 20039, 20046, 20093, 20095, 20100, and 20101.*

**20109** (DHEW/FDA-75-8010, pp 86-88) PLAN TO STUDY THE USE OF NUCLEAR MEDICINE IN THE UNITED STATES. Gitlin, J. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Programs to accumulate information on nuclear medicine procedures, and eventually to establish guidelines for the clinical indications for specific procedures and develop information on cost-benefit analyses at both the hospital and State level are discussed. Followup programs would evaluate the contributions to diagnosis of the various procedures. It is proposed to develop a computerized data acquisition system on nuclear medicine procedures. (CH)

**20110** INCUBATION CONDITIONS DURING THE RADIOIMMUNOASSAY OF PLASMA RENIN ACTIVITY. Fleming, L. W.; Stewart, W. K.; Hutchinson, F. (Univ. of Dundee, Eng.). Clin. Chim. Acta; 50: No. 2, 215-222(Jan 1974).

Variations are rife in reported methods for the measurement of plasma renin activity by radioimmunoassay of angiotensin *I* production. The concentrations of dimercaprol and of 8-hydroxyquinoline during the incubation stage are critical. The pH during incubation affects the ratio of radioimmunoactive to bioactive activity found. Variations in incubation conditions reported in the literature are reviewed and a plea is made for standardization now, while commercial assay kits are in process of being introduced. (NL)

**20111** INCORPORATION OF RADIOACTIVE LEUCINE AND FUCOSE IN BRAIN PLASMA MEMBRANE PROTEINS FRACTIONATED BY POLYACRYLAMIDE GEL ELECTROPHORESIS. Hemminki, K. (Univ. of Helsinki). Biochim. Biophys. Acta-Protein Struct.; 359: No. 1, 83-89(Jul 1974).

Plasma membranes were prepared from the cortices of 4 to 6 days old rats by homogenization and gradient centrifugation. In vivo labelling of plasma membrane proteins and glycoproteins with leucine and fucose, respectively, was characterized by a delayed appearance of radioactivity in plasma membranes as compared to the homogenate. Major proteins of the plasma membranes had apparent molecular weights of 94,000, 72,000 and 57,000 as determined by gel electrophoresis. Two prominent glycoproteins were detected at about 99,000 and 96,000 daltons. The incorporation of $^3H$-leucine and $^3H$-fucose in plasma membranes was most active in gel regions containing the prominent bands. However, the specific radioactivities of the amido black-stained proteins labelled with $^3H$-leucine and separated by gel electrophoresis indicated slow labelling of the major polypeptides. After 2 or 48 h incorporation, their relative specific radioactivities varied no more than 2-fold. (NL)

**20112** RAPID RADIOIMMUNOASSAY FOR THE EVALUATION OF THYROXINE IN UNEXTRACTED SERUM. Hermann, J.; Rusche, H. J.; Krueskemper, H. L. (Univ., Duesseldorf, Ger.). Clin. Chim. Acta; 54: No. 1, 69-71(Jul 1974).

A radioimmunoassay (RIA) for measurements of thyroxine (T4) in unextracted serum is presented. The assay is characterized by the use of specific thyroxine binding rabbit antiserum in a final dilution of 1 : 2000 and 8-anilinonaphthalen 1-sulfonic acid (ANS, 600 $\mu$g per test-tube) for the displacement of T4 from its binding with thyroxine binding globulin. The setting up of the assay is half automatic, the working time is short, only 25 $\mu$l of serum are needed for one sample, the displacement of thyroxine from serum protein by ANS is almost complete, the sensitivity of the assay is far greater than that of displacement methods, the standard curve is linear from 0.24 to 60 $\mu$g T4/dl, thereby allowing accurate measurements over a wide range in one attempt. The overall agreement between the results obtained using the RIA and a displacement technique in 189 sera of different thyroxine concentrations was good ($r = 0.9407$). The discrepancies observed between the results when obtained from radioimmunoassay or displacement techniques seem to depend on the methodological problems of a non-adjusted displacement method. (NL)

**20113** REVIEW OF METHODS AND METABOLIC STUDIES ASSOCIATED WITH THE RADIOIODINATION OF LIPOPROTEINS. Fidge, N. (Australian National Univ., Canberra). Clin. Chim. Acta; 52: No. 1, 5-13(Apr 1974).

The labelling of lipoproteins with iodine radioisotopes is reviewed. Also the possible changes in catabolism of the labelled lipoproteins are reported. These alterations can be caused by the specific labelling method. (NL)

**20114** BIOSYNTHESIS OF STEROIDS FROM $^{14}$C CHOLESTEROL, $^{3}$H PROGESTERONE AND $^{3}$H PREGNENOLONE BY HUMAN ADRENAL CARCINOMA TISSUES. Nishida, S.; Jungmann, R. A. (Kawasaki Medical Coll., Kurashiki, Japan). Clin. Chim. Acta; 52: No. 1, 97-103(Apr 1974).

Slices prepared from human adrenal carcinoma tissue obtained from a 51-year-old female with virilism were incubated with $^{14}$C-cholesterol, $^{3}$H-progesterone, or $^{3}$H-pregnenolone. The tissue homogenates were analyzed for steroids by the reverse isotope dilution method. Purification and identification of the radioactive metabolites were achieved by column, paper, and thin-layer chromatography, derivative formation, and crystallization to constant specific activity. The major androgen metabolites were dehydroepiandrosterone (DHEA) and androstenedione in the large ratio of DHEA/androstenedione. Some evidence was found for the possibilities of a relative deficiency in the 3$\beta$-dehydrogenase system or inhibition of 3$\beta$-hydrogenase activity under the conditions of the experiment. Pathways for DHEA and androstenedione formation by the adrenal carcinoma tissue are suggested. (NL)

**20115** POWER-POINT SYSTEM TO EVALUATE RADIOIMMUNOASSAYS. Cerceo, E. (Thomas Jefferson Univ., Philadelphia). Lab. Pract.; 23: No. 11, 625-629(Nov 1974).

A relatively simple and straight-forward method for the evaluation of competitive radioassay curves through a power-point system is presented. This system rates the assay on the basis of the percent binding of the "zero" standard, extent of displacement of the radioactively-labelled component from the binding agent by non-radioactively-labelled component, accuracy, precision, and sensitivity. This system has proven advantageous in the following areas: in showing the performance level of a radioassay, comparing different techniques for the same assay, indicating where improvement is necessary, and acting as a simplified yet fairly comprehensive quality control standard. (auth)

**20116** EFFECTS OF METHODOLOGICAL VARIABLES ON INSULIN RADIOIMMUNOASSAY. Malvano, R.; Quesada, T.; Rolleri, E.; Gandolfi, C.; Zucchelli, G. C. (National Research Council, Pisa, Italy). Clin. Chim. Acta; 51: No. 2, 127-139(Mar 1974).

The effects of methodological variables on the quality of insulin radioimmunoassay were studied, including the individual characteristics of antiserum and tracer preparations, the incubation modality, the procedure of separation of free from bound antigen and the non-identity of sample and standard solutions as for the protein content. A number of experimental factors were expectedly found to influence the sensitivity of response. Conversely, important effects on assay accuracy were found to be associated only with the double-antibody method used and with non-identity of samples and standards. The results of investigations on the possible sources of the systematic errors involved and on their relevance in routine measurements are reported and discussed. (NL)

**20117** TRIIODOTHYRONINE RADIOIMMUNOASSAY: A STUDY OF THE INTERACTIONS OF $T_3$ WITH ANTI-$T_3$ ANTISERA AND WITH THYROXINE BINDING GLOBULIN IN THE PRESENCE OF ANS (AMMONIUM-8-ANILINO NAPHTALENE-1- SULFONATE). Malkus, H.; Donabedian, R. K. (Yale Univ., New Haven). Clin. Chim. Acta; 51: No. 2, 191-198(Mar 1974).

Two different antisera against triiodothyronine ($T_3$) were studied in an assay system for $T_3$ in serum utilizing ammonium-8-anilino naphthalene-1-sulfonate (ANS) as an uncoupler of $T_3$ from thyroxine binding globulin (TBG). The effect of increasing amounts of ANS on the reaction between $T_3$ and anti-$T_3$ antisera and the effects of varying amounts of thyroxine binding globulin as well as thyroxine on the dynamics of the reactions were investigated. It is shown that in a radioimmunoassay system involving two binders ($T_3$ antibody and TBG) for a given ligant ($T_3$) it is important, in the evaluation of the antisera, to study its behaviour in the presence of varying amounts and states of saturation of the other naturally occurring binder (TBG). (NL)

**20118** AUTORADIOGRAPHY OF PLANTS. Isermann, K. Bild Wiss.; 11: No. 5, 42-44(May 1974). (In German).

4 figs.

Autoradiography is said to be considerably improved with the help of the equidensity technique. Nutritive substance transport from the ground up to the fruit or leaf tip appears in intense colors and enables a better insight into the metabolic process of the plants. (GE)

**20119** THE EFFECTS OF CYTOSTATIC AGENTS ON SHORT-TERM CULTURES ($^{3}$H-URIDINE INCORPORATION) AND TISSUE CULTURES (CELL COUNTS) FROM HUMAN TUMORS. Mattern, J.; Wayss, K.; Volm, M. (Deutsches Krebsforschungszentrum, Heidelberg (F. R. Germany). Inst. fuer Experimentelle Pathologie). Arch. Gynaekol.; 216: No. 3, 273-279(1974). (In German).

5 figs.; 1 tab.; 13 refs.

The previously established correlation between cell counts in tissue cultures and $^{3}$H-uridine incorporation in cell suspensions on treatment with various cytostatic agents was also shown to be applicable to 2 human ovary carcinomas. The clinical importance of these results is discussed. (auth)

**20120** PREPARATION OF $^{125}$I-LABELED ESTRONE-TRITYROSINE METHYL ESTER. Kato, H.; Ito, T.; Kido, Y.; Torigoe, T. (Yamaguchi Univ., Ube (Japan). Dept. of Obstetrics and Gynecology). Horm. Metab. Res.; 6: No. 4, 334-335(Jul 1974).

3 figs.; 4 refs.

A method of preparing Estrone ($E_1$)–trityrosine methyl ester (TTME) conjugate, and its application to $E_1$-radioimmunoassay as a labeled tracer is described. (auth)

**20121** USE OF 17$\beta$-OESTRADIOL-6-(O-CARBOXYMETHYL) OXIME-($^{125}$I)TYRAMINE AS TRACER FOR THE RADIOIMMUNOASSAY OF 17$\beta$-OESTRADIOL. Lindberg, P.; Edquist, L. E. (Kungliga Veterinaerhoegskolan, Stockholm). Clin. Chim. Acta; 53: No. 2, 169-174(Jun 1974).

17$\beta$-Oestradiol 6-(O-carboxymethyl)oxime was conjugated to $^{125}$I-tyramine. A maximum specific activity of 6200 $\mu$Ci/$\mu$g was was obtained. This high specific activity permitted a dilution of the antiserum of 1 : 1200000) in radioimmunoassay of 17$\beta$-oestradiol. Using this dilution 1 ml of the antiserum yields 120000000 assay units. The high specific activity of the iodinated tracer also made possible the use of radioimmunoassay systems detecting levels below 1 pg of 17$\beta$-oestradiol. After 6 months of storage of one iodinated steroid tracer it was still suitable for use in the radioimmunoassay system. (NL)

**20122** TECHNETICUM-99m SULFUR COLLOID SPLEEN/LIVER RATIO AND OTHER LIVER FUNCTION TESTS IN THE DIAGNOSIS OF CIRRHOSIS. Habibian, M. R.; Kutka, N.; Wilkinson, R. H. Jr.; Goodrich, J. K.; Harris, C. C. (Duke University, Durham, NC). S. Med. J.; 68: No. 1, 5-12(Jan 1975).

The results of seven laboratory tests of liver function, including spleen/liver activity ratios obtained by densitometric analysis of scans, are analyzed in 50 patients with proven Laennec's cirrhosis. In this series, the liver scan not only disclosed the liver gross anatomy and structural abnormality and established the best possible site for biopsy examination, but also, the increased splenic activity served as a useful diagnostic indication of Laennec's cirrhosis. Of 50 proven cases of Laennec's cirrhosis, 41 (82%) had abnormal spleen/liver ratios. An abnormal spleen/liver ratio in combination with abnormal results from any one or two other tests was relatively effective in the detection of cirrhosis. The accuracy is improved if the other laboratory tests are chosen from among tests for serum albumin, serum bilirubin, and SGOT. (Liver abnormalities other than cirrhosis can also present an abnormal spleen/liver ratio.) This sim-

ple determination extends the value of the liver scan commonly requested in search of metastases, primary lesions, or inflammatory processes, or in preparation for needle biopsy examination. (auth)

**20123** PURIFICATION, CHARACTERIZATION, AND RADIOIMMUNOASSAY OF THYROCALCITONIN FROM RAT THYROID GLANDS. Burford, H. J.; Ontjes, D. A.; Cooper, C. W.; Parlow, A. F.; Hirsch, P. F. (Univ. of North Carolina, Chapel Hill). Endocrinology; 96: No. 2, 340-348(Feb 1975).

A highly purified preparation of rat thyrocalcitonin (TCT) has been obtained from lyophilized thyroid glands by gel chromatography following acid-acetone extraction. Biological activity of Sephadex G-50 eluates appeared in two peaks. The TCT in the major peak was concentrated, and applied to a Bio-Gel P-6 column, and a major protein peak was eluted which coincided with TCT activity. Potency, estimated by bioassay in rats, increased approximately 3500-fold from 0.075 MRC U/mg lyophilized glands to 250-400 MRC U/mg in the final product. The overall yield of TCT activity was about 36%. The purified product was characterized by chemical procedures and evaluated for its antigenic properties and use for radioimmunoassay. The purified rat TCT was used both labeled with $^{125}I$ and as unlabeled standard. The following results were obtained: (1) Guinea pig antisera to either human or rat TCT were capable of binding $^{125}I$-rat TCT or $^{125}I$-human TCT; (2) Using either $^{125}I$-human or $^{125}I$-rat TCT and antisera to either TCT, pg amounts of rat and human TCT reacted in the assay while ng to μg amounts of salmon calcitonin or porcine TCT failed to react; (3) Using $^{125}I$-rat TCT and antisera to human or rat TCT, synthetic C-terminal (10-32 or 22-32) fragments of human TCT reacted well, while N-terminal (1-18) or desamide (1-32) derivatives reacted poorly or not at all; (4) Rat TCT was easily detected in normal thyroid venous plasma (5-10 ng/ml) and thyroid gland extracts (~1 μg/gland) but not in peripheral blood; (5) Bioassay and radioimmunoassay of rat thyroid extracts ($N = 18$) showed good agreement ($r = 0.86$, $p < 0.001$). The results support the idea that rat TCT is closely related to human TCT, indicate that major antigenic determinants reside in the C-terminal portion of the molecule, and show that antisera to either human or rat TCT can be used to measure rat TCT. (auth)

**20124** RADIOIMMUNOASSAY FOR LUTEINIZING HORMONE-RELEASING HORMONE (LHRH): ITS APPLICATION TO THE MEASUREMENT OF LHRH IN OVINE AND HUMAN PLASMA. Jonas, H. A.; Burger, H. G.; Cumming, I. A.; Findlay, J. K.; de Kretser, D. M. (Prince Henry's Hospital, Melbourne). Endocrinology; 96: No. 2, 384-393(Feb 1975).

A radioimmunoassay for LHRH, modified from the assay of Nett et al. and characterized in more detail, was applied to the measurement of endogenous plasma LHRH in the peripheral circulation of ewes and women around the time of gonadotropin release. Sensitivity was 1.2 pg/tube. Within- and between-assay coefficients of variation were 10% and 25%, respectively, over the range 10-100 pg/tube. Minimal cross reaction (<0.1%) was observed with LHRH analogues tested, except those which had undergone single amino acid alterations in the 4 or 8 positions (62-93%) and in the 1 position (1-3%). Inhibition curves parallel to synthetic LHRH were obtained with these immunoreactive analogs, and with crude hypothalamic and pituitary extracts from 16 cycling ewes and 3 pooled hypothalamic extracts from male rats. LHRH contents of ovine hypothalami and pituitaries ranged from 1.9-10.2 (4.5 ± 2.1, mean ± SD) and 0-27.5 (4.2 ± 7.3, mean ± SD) ng LHRH, respectively, with no obvious correlation between the contents of either tissue. LHRH contents of pooled hypothalami from normal, castrated and castrated-hypophysectomized male rats were 4.5, 2.9 and 1.3 ng/hypothalamus. Recovery of synthetic LHRH added to plasma was quantitative, provided the storage time at 4 and 20 C was minimal. Synthetic LHRH administered to ewes by intravenous infusion or subcutaneous injection was readily detectable in peripheral plasma. The metabolic clearance rates of synthetic LHRH in 3 sheep were 14, 11 and 14.1/day/kg, respectively. Endogenous immunoreactive material in single, unextracted plasma samples from sheep in various physiological states ranged from 0-400 pg/ml. However, the endogenous plasma immunoreactivity in these samples bore no resemblance to synthetic LHRH added to ovine plasma in that it was stable to gentle heat, and was undetectable after methanol extraction. No endogenous LHRH could be detected in methanol extracts of peripheral plasma obtained from estrous ewes or oophorectomized ewes injected iv with estradiol-17β (40 μg) and bled at 15 min intervals prior to gonadotropin release. Single daily plasma samples obtained from three normal women over their entire menstrual cycles contained no significant levels of endogenous LHRH. (auth)

**20125** PREPARATION AND PHOTOCHEMICAL PROPERTIES OF STRAND-SPECIFIC 5-BROMOURACIL-SUBSTITUTED LAMBDA PHAGE. Ihler, G. (Univ. of Pittsburgh). Radiat. Res.; 61: No. 2, 298-303(Feb 1975).

A procedure is described for preparing lambda phage labeled in either strand r or *l* with radioisotopes, 5-bromouracil, or both. Phage containing 5-bromouracil in strand r have the same photosensitivity to near-visible light as phage containing 5-bromouracil in strand *l*. Lesions in both types of phage DNA can be repaired to the same extent by the bacterial DNA excision repair system. (auth)

**20126** ADSORPTION ONTO DEXTRAN-COATED CHARCOAL AS A RAPID METHOD FOR $^{125}I$-LABELLED INSULIN DAMAGE ASSESSMENT. Proszynska, K.; Sadowska, B. (Inst. of Nuclear Research, Warsaw). Clin. Chim. Acta; 53: No. 1, 5-10(May 1974).

The measured percentage adsorption of $^{125}I$-labelled insulin onto dextran-coated charcoal enable a quick and sensitive determination of its immunological activity. When the adsorption exceeds 95% of the total radioiodine activity, then the immunological activity of the labelled insulin is considered to be high. (NL)

**20127** IMPROVED ASSAY FOR PLASMA OESTRADIOL USING COMPETITIVE PROTEIN BINDING. Pratt, J. J.; van der Linden, G.; Doorenbos, H.; Woldring, M. G. (Rijksuniversiteit Groningen, Netherlands). Clin. Chim. Acta; 50: No. 1, 137-146(Jan 1974).

An improved oestradiol assay using the binding protein from rabbit uterus is described. Improvements in the extraction and purification of the plasma oestradiol make the method more reliable and suitable for routine use in the clinical laboratory. Improvement of the sensitivity increases the number of potential applications of the method. (NL)

**20128** RADIOIMMUNOASSAY STUDY AND COMPARISON OF SEASONAL VARIATION IN PLASMA TRIIODOTHYRONINE AND THYROXINE CONCENTRATIONS IN NORMAL HEALTHY PERSONS. Postmes, T. J.; van Hout, J. C.; Saat, G.; Willems, P.; Coenegracht, J. (St. Annadal Ziekenhuis, Maastricht, Netherlands). Clin. Chim. Acta; 50: No. 2, 189-195(Jan 1974).

The serum triiodothyronine (T3) and thyroxine (T4) concentration of healthy persons remains almost constant for at least ten months. Fresh serum and serum frozen for two years were compared. The main difference in T3 concentration is negligible, only 3 ng/100 ml. The radioimmunoassay has a Between Assay Coefficient of 6.3% and is therefore reliable. Results can be obtained within 24 h. (NL)

**20129** DIMINISHED UPTAKE OF $^{67}Ga$-CITRATE IN A CASE OF PSEUDARTHROSIS. Hurwitz, S. R.; Quinto, R. R. (Univ. of California, San Diego). J. Nucl. Med.; 16: No. 2, 167-169(Feb 1975).

A 22-year-old man with pseudarthrosis and infection of the right hip was referred for a $^{67}Ga$-citrate scan. A striking decrease was seen in normal bone and soft-tissue uptake in the entire right leg compared with the normal limb. Aortic injection of $^{99m}Tc$-labeled microspheres showed increased trapping in the region of the hip but contrast angiography was unremarkable. Despite clinical improvement, $^{67}Ga$ uptake by the right leg on a repeat scan did not return to normal. This case represents the first report of a photon-deficient body part on $^{67}Ga$ scanning. (auth)

**20130** RADIOCOLLOID SCANS IN EVALUATING SPLENIC RESPONSE TO EXTERNAL RADIATION. Spencer, R. P.; Knowlton, A. H. (Univ. of Connecticut, Farmington). J. Nucl. Med.; 16: No. 2, 123-126(Feb 1975).

By use of $^{99m}Tc$-sulfur colloid, splenic size as well as liver/spleen ratio of radioactivity was determined after external irradiation of the abdomen. In six patients receiving about 2,000 R whole-abdominal radiation, there was no atrophy of the spleen or abnormal distribution in the liver/spleen ratio of radioactivity (that is, the spleen was still functional). Serial studies in a 7-year-old boy with acute lymphoblastic leukemia in remission showed that 1,450 R splenic radiation did not result in any appreciable change in the length of the organ. In a woman with lymphosarcoma, a change in spleen size did not occur until a dose of 1,800 R was delivered. Another patient had apparently normal uptake of radiocolloid 5 years after 3,600 R. Hence the normal spleen and the spleen affected by other diseases may be far more resistant to external radiation than the spleen diseased with chronic myelocytic leukemia. Spleen scans can be useful in documenting the response of the organ to radiation. (auth)

**20131** CHEMICAL AND BIOLOGIC PROPERTIES OF $^{111}In$-PHOSPHATE FOR CISTERNOGRAPHY AND GLOMERULAR FILTRATION STUDIES. Johnson, A. E.; Gollan, F. (Veterans Administration Hospital, Miami, FL). J. Nucl. Med.; 16: No. 2, 164-166(Feb 1975).

Inorganic $^{111}$In-phosphate has been evaluated for cisternography in dogs, rats, and one human volunteer for chemical and biologic stability and renal clearance. It appears to be stable and to be completely cleared by glomerular filtration, suggesting its suitability for cisternography. (auth)

**20132** THALLIUM-201 FOR MEDICAL USE. II. Biologic Behavior. Bradley-Moore, P. R.; Lebowitz, E.; Greene, M. W.; Atkins, H. L.; Ansari, A. N. (Brookhaven National Lab., Upton, NY). J. Nucl. Med.; 16: No. 2, 156-160(Feb 1975).

Thallium-201 has been evaluated for myocardial imaging by determining its distribution and assessing its imaging properties. Organ distribution with time was studied in goats, chosen for their large size and easy operability. Myocardial imaging was performed in living and sacrificed goats and also in two anesthetized dogs, without infarction. Infarcts were made by ligature at open chest surgery on the goats and the infarcts subsequently confirmed histologically. The myocardium of normal and infarcted, young and old goats was cut into blocks and the isotope distribution measured and compared with that in the lungs, liver, spleen, and kidney in normal goats. The renal medulla-to-cortex concentration ratio in goats was studied and is approximately five. The heart uptake exceeds 3% for 100 min whereas contiguous organs have less than one-half of the myocardial concentration, and blood clearance is rapid. One problem may prove to be inhomogeneity of uptake of thallium in the "normal" myocardium, showing a standard deviation of 11% in a young goat and 29% in an old goat. In view of the good myocardial uptake, however, this work strongly suggests the trial of $^{201}$Tl in patients. (auth)

**20133** THALLIUM-201 FOR MEDICAL USE. I. Lebowitz, E.; Greene, M. W.; Fairchild, R.; Bradley-Moore, P. R.; Atkins, H. L.; Ansari, A. N.; Richards, P.; Belgrave, E. (Brookhaven National Lab., Upton, NY). J. Nucl. Med.; 16: No. 2, 151-155 (Feb 1975).

Thallium-201 merits evaluation for myocardial visualization, kidney studies, and tumor diagnosis because of its physical and biologic properties. A method is described for preparation of this radiopharmaceutical for human use. A critical evaluation of $^{201}$Tl and other radiopharmaceuticals for myocardial visualization is given. (auth)

**20134** GALLIUM GALLBLADDER SCANNING IN CHOLECYSTITIS. Waxman, A. D.; Siemsen, J. K. (Univ. of Southern California, Los Angeles). J. Nucl. Med.; 16: No. 2, 148-150 (Feb 1975).

Gallium has been shown to accumulate in metabolically active tissue including sites of infection. The purpose of this study was to evaluate gallium scanning in cholecystitis. Ten patients with cholecystitis were studied using conventional gallium scanning techniques. Five patients with acute cholecystitis showed intense gallium accumulation in the gallbladder area. One of five patients with chronic cholecystitis showed significant accumulation in the gallbladder. The limitations of this method are mainly the need for serial scanning to rule out gallium accumulation in the hepatic flexure of the colon and also the failure to detect consistently a chronically diseased fibrotic gallbladder. We conclude that gallium scanning of the gallbladder is an important adjunctive study in the evaluation of cholecystitis. (auth)

**20135** DISTRIBUTIONS OF SEVERAL AGENTS USEFUL IN IMAGING MYOCARDIAL INFARCTS. Bonte, F. J.; Parkey, R. W.; Graham, K. D.; Moore, J. G. (Univ. of Texas, Dallas). J. Nucl. Med.; 16: No. 2, 132-135(Feb 1975).

Myocardial cell death due to infarction is accompanied by an influx of calcium ion. The calcium ion seems to localize in crystalline structures that form within mitochondria and resemble hydroxyapatite. Based on this phenomenon $^{99m}$Tc-stannous pyrophosphate has been successfully used to image myocardial infarcts within 24 hr of infarction and within 1 hr following tracer administration both in dogs and patient volunteers. In this report, canine distribution studies of $^{99m}$Tc-pyrophosphate are compared with similar studies with $^{99m}$Tc-stannous polyphosphate, $^{99m}$Tc-stannous 1, hydroxy-ethylidene-1, 1-disodium phosphonate diphosphonate, and $^{18}$F as sodium fluoride. Pyrophosphate, polyphosphate, and diphosphonate are each potentially useful in myocardial infarct imaging but bone uptake of $^{18}$F occurs sufficiently early to prevent the use of this radionuclide in infarct scintigraphy. (auth)

**20136** RELATIVE TISSUE DISTRIBUTION OF RADIOACTIVITY IN RATS WITH ENDOCRINE AUTONOMOUS BREAST CARCINOMAS AFTER $^{3}$H-$^{99m}$Tc-, AND $^{64}$Cu-BLEOMYCIN. Ryo, U. Y.; Ice, R. D.; Jones, J. D.; Beierwaltes, W. H. (Univ. of Michigan, Ann Arbor). J. Nucl. Med.; 16: No. 2, 127-131(Feb 1975).

The localization of $^{64}$Cu-, $^{3}$H-, and $^{99m}$Tc-labeled bleomycin was studied in tissues of Fisher rats bearing an endocrine autonomous breast tumor. The $^{64}$Cu-bleomycin showed a greater uptake than $^{3}$H- and $^{99m}$Tc-bleomycin in the breast tumor at all time intervals studied, from 2 to 72 hr after the tracer. This same differential uptake was shared by the liver and kidney. (auth)

**20137** SIGNIFICANCE OF RENAL ASYMMETRY IN BONE SCANS: EXPERIENCE IN 795 CASES. Hattner, R. S.; Miller, S. W.; Schimmel, D. (Univ. of California, San Francisco). J. Nucl. Med.; 16: No. 2, 161-163(Feb 1975).

A retrospective study of 795 consecutive bone scans employing either $^{18}$F or $^{99m}$Tc-pyrophosphate to evaluate the diagnostic value of renal asymmetry in such scans has been carried out. It is concluded that asymmetric renal images in bone scans convey relatively specific information regarding renal pathology, especially in the $^{99m}$Tc-pyrophosphate studies. (auth)

**20138** RADIOLABELED ANTITUMOR ANTIBODIES. I. Antibody-Specific and Immunoglobulin-Specific Binding Sites on Moloney Lymphoma Cells (LSTRA). Nord, S.; Weissman, I. L. J. Nat. Cancer Inst.; 53: No. 1, 117-124(Jul 1974).

A paired, radiolabeled immunoglobulin technique was used to show that LSTRA Moloney lymphoma cells may bind rat IgGa immunoglobulins at either antibody-specific (Fab) or immunoglobulin-specific (Fc) portions of the IgGa molecule. Fc-specific binding is inhibited in the presence of normal rat serum (NRS), whereas Fab-specific binding is not. Sodium dodecyl sulfate-polyacrylamide gel analysis of eluted radiolabeled anti-Moloney proteins (bound to LSTRA cells in the presence of NRS) revealed that the bound proteins were indeed immunoglobulin. (auth)

**20139** DEVELOPMENT OF A NEW RADIOACTIVE ASSAY FOR TRYPSIN AND PAPAIN AND ITS APPLICATION TO THE STUDY OF THE INHIBITION OF PAPAIN BY PEPTIDE CHLOROMETHYL KETONES. Roffman, S. L. New York; New York Univ. (1974). 71p. University Microfilms Order No. 74-30,038.

Thesis (Ph. D.).

Chemical carcinogenesis studies in mouse skin have led to the proposal that a proteolytic enzyme may play a role in tumor formation since the level of a proteolytic enzyme in mouse skin increases after topical application of the cocarcinogen phorbol ester. Both tumor formation and this enzyme are inhibited by the protease inhibitors p-toluenesulfonyl-L-phenylalanine chloromethyl ketone (TPCK) and p-toluenesulfonyl-L-lysine chloromethyl ketone (TLCK). These studies have led to the work presented here in which the sulfhydryl protease, papain, was used as a model to study the mouse skin protease which has not been isolated. The nature of papain's active site was investigated by inhibiting papain with a variety of amino acid and peptide chloromethyl ketones. Also, an assay was developed to specifically assay low levels of papain. The assay measures the increase in tritiated aniline released during the enzymatic hydrolysis of the substrate N-benzoyl-DL-arginine [$^{3}$H]anilide. The assay is continuous since the reaction is carried out in a scintillation vial containing a biphasic system of an aqueous enzyme-substrate solution beneath a layer of toluene-scintillant solution. The [$^{3}$H] aniline released spontaneously diffuses into the toluene and is counted directly. Submicrograms of both trypsin and papain can be assayed and rates of hydrolysis as low as 16 picomoles anilide hydrolyzed/min. are measurable. The assay is about $10^{6}$ times more sensitive than the colorimetric assay using benzoyl-DL-arginine-p-nitroanilide. (Diss. Abstr. Int., B)

**20140** EXPERIENCE WITH $^{111}$In-CHLORIDE SCANNING IN PATIENTS WITH FOCAL DEFECTS ON $^{99m}$Tc-SULFUR COLLOID LIVER SCANS. Abdel-Dayam, H. M.; Elkousy, A. M.; Leslie, E. V.; Panaro, V. A. (New York State Univ., Buffalo). Radiology; 114: No. 2, 403-406(Feb 1975).

From 59th scientific assembly of the Radiological Society of North America; Chicago, IL (25 Nov 1973).

Thirty-nine patients with focal defects on the technetium liver scan were rescanned using $^{111}$In chloride. Of 20 patients with hepatic malignancy, 11 had positive indium scans. None of the 19 with focal cirrhotic fibrosis had a positive indium scan although 5 of these had primary extrahepatic tumors. Two of these 5 patients showed indium uptake in the primary tumor. Thus, a positive indium scan suggests that the defect is malignant. A negative indium scan is less helpful, failing to distinguish between neoplasm and focal cirrhosis. Positive uptake in an extrahepatic primary neoplasm and negative uptake in the liver suggest that the hepatic lesion is not neoplastic. (auth)

**20141** RADIOLABELED ANTITUMOR ANTIBODIES. II. Quantitative Analysis of Moloney Tumor Antigens on Moloney Lymphoma Cells (LSTRA). Nord, S.; Weissman, I. L. J. Nat. Cancer Inst.; 53: No. 1, 125-130(Jul 1974).

Radiolabeled anti-Moloney antiserum in a paired radiolabel technique detected $\approx 5 \times 10^{4}$ Moloney antigen-specific sites/LSTRA Moloney lymphoma cell. The calculated average association con-

stant ($K_A$) for this radiolabeled antibody on LSTRA cells was $7.8-20 \times 10^7$ liters/mole. (auth)

**20142** HUMAN IMMUNE RESPONSE TO ACTIVE IMMUNIZATION WITH RAUSCHER LEUKEMIA VIRUS. II. Humoral Immunity. Hersh, E. M. (Univ. of Texas, Houston); Hanna, M. G. Jr.; Gutterman, J. U.; Mavligit, G.; Yurconic, M. Jr.; Gschwind, C. R. J. Nat. Cancer Inst.; 53: No. 2, 327-333(Aug 1974).

Of 20 patients immunized with 100 μg formalin-killed Rauscher leukemia virus (RLV) every 2 weeks for 8 weeks, 10 developed a significant antibody titer as measured by a radioimmunoprecipitation assay. Among the responders, the mean titer, taken as the reciprocal of the highest serial twofold dilution yielding 50% virus precipitation, was ≈1: 354. Antibody first appeared 2 weeks after immunization and reached a peak of 8 weeks. Antibody responses were most vigorous in patients with melanoma and in those receiving BCG plus chemotherapy; responses were least vigorous in patients with other solid tumors or acute leukemia, and in those receiving chemotherapy without immunotherapy. Correlation was excellent between the antibody response and the development of delayed hypersensitivity to the virus ($P = 0.005$) and between the antibody response and in vitro lymphocyte blastogenic response to an antigen solubilized from RLV-infected cells ($P = 0.025$). Extensive absorption studies indicated that sera from both immunized and nonimmunized subjects contained antimouse antibody. After in vivo absorption in mice, patients' postimmunization sera retained antiviral activity. (auth)

**20143** DETECTION OF HYPERTROPHIC PULMONARY OSTEOARTHROPATHY BY SKELETAL IMAGING WITH $^{99m}$Tc-LABELED DIPHOSPHONATE. Donnelly, B.; Johnson, P. M. (Columbia Univ., New York). Radiology; 114: No. 2, 389-391 (Feb 1975).

In two patients with carcinoma of the lung, abnormal findings on skeletal imaging using $^{99m}$Tc-diphosphonate correctly suggested the diagnosis of hypertrophic pulmonary osteoarthropathy, which was later confirmed radiographically. A scintigraphic pattern of abnormal tracer localization distinguishes this benign condition of bone from bony metastases. (auth)

**20144** SOLID-PHASE RADIOIMMUNOELECTROPHORESIS: AN ASSAY FOR CARCINOEMBRYONIC ANTIGEN. Saravis, C. A. (Boston City Hospital); Zamcheck, N.; Kupchik, H. Z.; McCabe, R. P.; Munjal, D. J. Nat. Cancer Inst.; 53: No. 4, 921-926(Oct 1974).

The use of affinity chromatography beads fixed in electrophoretic media to which macromolecules were electrically transported, combined with the sensitivity and reproducibility of isotopic measurement, provided a potentially useful method for the detection of macromolecules such as carcinoembryonic antigen (CEA). The present sensitivity determined with CEA diluted in human serum permitted the detection of 5 to 10 ng/ml, a level too high to detect most cases of early cancer but possibly suitable for use as a method for performing serial assays used as a monitor of therapy for metastatic disease. Development of improved affinity media will increase the reproducibility and sensitivity of the solid-phase radioimmunoelectrophoresis technique to a level comparable to available radioimmunoassays for CEA. Other studies are required to determine if the present technique could be used to detect other clinically important macromolecules. (auth)

**20145** RADIOLABELED ANTITUMOR ANTIBODIES. III. Highly Iodinated and Highly Radioiodinated Antibodies. Nord, S.; Weissman, I. L. J. Nat. Cancer Inst.; 53: No. 4, 959-965(Oct 1974).

Antitumor antibodies could be iodinated and radioiodinated, and five-sixths (at 2 moles I/mole IgG) to one-third (at 21 moles I/mole IgG) of their antigen-binding activity could be retained, depending on the degree of iodination. Specific antibody inactivation by iodination involved denaturation of protein with increasing levels of iodination, presumably by a change in the charge structure and autoalteration of radioiodinated immunoglobulin as a result of radioactive decay. The first mode of inactivation increased the nonspecific binding of rat immunoglobulin to Moloney lymphoma cells (LSTRA) with higher levels of iodination, whereas it decreased the antibody-specific binding. In vivo absorption of these highly iodinated antibodies led to a selective loss of the subpopulation of iodinated anti-Moloney immunoglobulins which nonspecifically bind to LSTRA cells. (auth)

**20146** BINDING OF CARCINOEMBRYONIC ANTIGEN (CEA) TO CONCANAVALIN A-SEPHAROSE: STORAGE OF HIGH-SPECIFIC-ACTIVITY $^{125}$I– CEA. David, G. S.; Reisfeld, R. A. (Scripps Clinic and Research Foundation, La Jolla, CA). J. Nat. Cancer Inst.; 53: No. 4, 1005-1010(Oct 1974).

The interaction of carcinoembryonic antigen (CEA) with Sepharose-bound concanavalin A (Con A) was used to devise a method of storing high-specific-activity $^{125}$I-CEA for prolonged use in radioimmunoassay systems. Antigenically active radiolabeled CEA bound strongly to Con A-Sepharose, whereas antigenically inactive radiolabeled degradation products were released from the beads and could be removed simply by washing the beads with buffer. The active $^{125}$I-CEA was eluted from the beads with 0.1M α-methyl-D-mannoside and could be used directly in the radioimmunoassay, since the glycoside did not interfere with antigen-antibody interactions. For example, one $^{125}$I-CEA sample (initially ≈ 26 μCi/μg), after storage without Con A-Sepharose for 72 days, could bind to CEA-specific antibody only to the extent of 49%, whereas the same antigen stored on, and eluted from, Con A-Sepharose exhibited 92% antibody-binding capacity. These data suggest the use of lectin-Sepharose conjugates for the storage of other radioiodinated glycoprotein antigens for similar purposes and the possibility of taking advantage of the binding properties of Con A-Sepharose for the isolation of CEA from tumor extracts. (auth)

**20147** SPECIFICITY OF $^{51}$Cr-RELEASE CYTOTOXICITY OF LYMPHOCYTES IMMUNE TO MURINE SARCOMA VIRUS. Herberman, R. B. (National Cancer Inst., Bethesda, MD); Aoki, T.; Nunn, M.; Lavrin, D. H.; Soares, N.; Gazdar, A.; Holden, H.; Chang, K. S. S. J. Nat. Cancer Inst.; 53: No. 4, 1103-1111(Oct 1974).

Cellular immune reactivity of C57BL/6 mice after inoculation with murine sarcoma was studied by the $^{51}$Cr-release cytotoxicity assay. The specificity of the reactions against a tumor target cell induced by Rauscher leukemia virus was examined with an inhibition test. Unlabeled target cells sharing antigens with the labeled target cells could competitively inhibit release of the radioisotope. The results obtained with this inhibition assay correlated well with those obtained with direct cytotoxicity tests against various target cells. C57BL/6 leukemia cells, induced by Friend, Moloney, or Rauscher viruses, could inhibit, and a Gross virus-induced leukemia was negative. However, further results revealed a pattern of specificity different from that seen with serologic reactions. Transplantable BALB/c leukemias, induced by Moloney or Rauscher viruses, gave consistently negative results. Most virus-induced tumors in other species were also negative. Several mouse cell lines spontaneously infected with endogenous C-type viruses were positive, whereas uninfected parental cells were negative. In addition, treatment of a negative cell line with bromodeoxyuridine, an agent causing expression of endogenous viral activity, induced the transient appearance of antigen. This study indicated that the antigens detected by the $^{51}$Cr-release cytotoxicity assay of cell-mediated immunity may be related to expression of an endogenous C-type virus, rather than to the murine sarcoma virus. This antigen has been tentatively designated MEV-SA-1. The study distinguished between antigenic specificities detected by humoral antibody and those detected by an assay of cell-mediated immunity. (auth)

**20148** USE OF RADIOIMMUNOELECTRO-OSMOPHORESIS FOR THE DIAGNOSIS OF HUMAN TRICHINOSIS. Dzbenski, T. H.; Plonka, W. S.; Jedrzejewska, B. (National Inst. of Hygiene, Warsaw). Experientia; 30: No. 11, 1269-1270(15 Nov 1974).

Antigen was prepared from muscle larvae and labeled with $^{125}$I. Immune sera were obtained from persons suspected of having recent infection with Trichinella spiralis. Figures are presented to show results of counterelectrophoresis and radioimmunoelectro-osmophoresis (RIEOP). The results of RIEOP were always unequivocal and enabled easy differentiation from nonspecific precipitation seen in counterelectrophoresis. However, the counterelectrophoresis method is much less expensive and much more rapid. (HLW)

**20149** RADIOIMMUNOASSAY FOR DOPAMINE-β-HYDROXYLASE USING A GLASS-BOUND ANTIBODY. Kashimoto, T.; Park, D.; Ebstein, R. P.; Goldstein, M.; Levitz, M.; Yaverbaum, S. (New York Univ., NY). Experientia; 30: No. 11, 1363-1364 (15 Nov 1974).

A new solid-phase assay for bovine DβH utilizing an antibody covalently bound to glass beads is described. In a typical assay a mixture of standard DβH or the sample, the glass bound antibody, and $^{125}$I-DβH was shaken and incubated for 16 h. A figure shows curves obtained following incubations of 2 and 16 h. Results indicate that the 16 h incubation with the glass bound antibody gave a greater percentage of binding and a greater range of linearity than that obtained following 2 h of incubation. The method was applied to the assay of DβH in bovine adrenal glands and various areas of the brain. Results indicated that this method is more specific than other methods; another advantage of the method is simplicity. (HLW)

**20150** POSSIBILITIES OF RADIOLOGICAL EPIGASTRIC DIAGNOSTICS. Jost, H. (Freie Univ. Berlin (F.R. Germany).

Strahlenklinik und Poliklinik). Therapiewoche; 24: No. 38, 4076-4084(Sep 1974). (In German).

7 figs.; 3 tabs.; 24 refs.

The possibilities of radiological epigastric diagnostics with the help of the x-ray method, investigation with contrast media, and nuclear medicine methods are reviewed. The risks and radiation exposure are also considered. With the exception of pancreas scintigraphy, the radiation exposure is quite small for nuclear medicine investigations. Contrary to this, there is a relatively high radiation exposure to be taken into account with abdominal angiography. The gonad exposure with an abdominal general radiograph for women can be estimated to be 120 to 150 mrad per picture. The radiation exposure of the cholecystography is relatively small with 0.6 to 5.2 mrad per picture. The value 9 to 20 mrad per film is given as an average value for stomach investigations. (GE)

**20151** ABSORPTION OF CALCIUM FROM THE DIGESTIVE TRACT MEASURED BY $^{47}$Ca. Kocian, J. (Interni Katedra Institutu Pro Dalsi Vzdelavani Lekaru a Farmaceutu, Prague (Czechoslovakia)); Brodan, V.; Skala, I. (1. Interni Vyzkumna Zakladna IKEM, Prague (Czechoslovakia)); Bakos, K. (Biofyzikalni Ustav Fakulty Vseobecneho Lekarstvi KU, Prague (Czechoslovakia)). Cas. Lek. Cesk.; 113: No. 12, 364-367(22 Mar 1974). (In Czech).

Measurements were made of the activity of perorally administered $^{47}$Ca in healthy people and in patients suffering from malabsorption. The activity was measured above the arm of the experimental persons, using an original external counter. The results were compared to the activity measured in the blood plasma. Within 60 min after the radioisotope administration the values differed little. Then a dissociation of both curves could be observed, with the activity resulting from $^{47}$Ca retained in the bones and other tissues of the arm prevailing. The total activity was found higher in healthy people, who showed a more rapid and intensive absorption of calcium from the digestive tract than malabsorption patients. (INIS)

**20152** SENSITIVE RADIOENZYMATIC ASSAY FOR NOREPINEPHRINE IN TISSUES AND PLASMA. Henry, D. P.; Starman, B. J.; Johnson, D. G.; Williams, R. H. (Univ. of Washington, Seattle). Life Sci.; 16: No. 3, 375-384(1 Feb 1975).

A procedure for measuring picogram quantities of norepinephrine has been developed utilizing partially purified bovine adrenal phenylethanolamine-N-methyl-transferase and $^{3}$[H]-S-adenosylmethionine. The sensitivity of the assay is 25 pg, and the procedure is applicable to many body tissues and fluids, including brain and plasma. (auth)

**20153** A PHYSIOLOGICAL METHOD FOR LABELLING PLASMA LIPOPROTEINS WITH RADIOACTIVE CHOLESTEROL. Sodhi, H. S.; Kudchodkar, B. J. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Medicine). Clin. Chim. Acta; 51: No. 3, 291-301(Mar 1974).

A number of in vitro methods were designed to incorporate radioactive cholesterol into plasma, but most of them have not proven satisfactory, except perhaps one, which appears promising in this regard. The plasma is labelled by transfer of radioactive cholesterol from red blood cells through a process of exchange, so that on theoretical grounds all the radioactive cholesterol should be present in plasma lipoproteins; this was supported by the experimental data. On agarose electrophoresis of the labelled samples, the radioactive cholesterol added through exchange with red blood cells was present only in association with lipoproteins, whereas significant fractions of the tracer incorporated by other methods in current use were not present with the lipoproteins. The rate of disappearance from circulation of radioactive cholesterol incorporated into plasma by the former method was similar to that of cholesterol native to lipoproteins, but the rates of disappearance of radioactive cholesterol incorporated into plasma by other methods was much faster than normal. Preliminary work has also suggested that the red blood cell exchange method can be successfully employed to study the metabolism of free cholesterol in isolated lipoproteins. (INIS)

**20154** ADSORPTION ONTO DEXTRAN-COATED CHARCOAL AS A RAPID METHOD FOR $^{125}$I-LABELLED INSULIN DAMAGE ASSESSMENT. Proszynska, K.; Sadowska, B. (Institute of Nuclear Research, Warsaw (Poland)). Clin. Chim. Acta; 53: No. 1, 5-10(May 1974).

The measured percentage adsorption of $^{125}$I-labelled insulin onto dextran-coated charcoal enable a quick and sensitive determination of its immunological activity. When the adsorption exceeded 95% of the total radioiodine activity, then the immunological activity of the labelled insulin was considered to be high. (INIS)

**20155** $^{131}$I-TOLUIDINE BLUE: USE IN SCINTIGRAPHIC LOCALIZATION OF ENLARGED PARATHYROIDS. An Experimental and Clinical Study. Normann, E. Oslo; Norsk Hydro's Institute for Cancer Research (1974). 37p.

Experiments reported using toluidine blue indicated the possibility of using intravenously injected radiolabelled toluidine blue to localize enlarged parathyroids. Five separate animal studies and one clinical study including ten patients have been reported previously in journal articles, and reprints of these are presented with a general introduction. Both tritium and I-125 labelled toluidine blue were used and compared with tritium labelled neutral red and Se-75 labelled selenomethionine. Tritium labelled toluidine blue was concentrated three times more in the parathyroids than in the thyroid, while no difference could be demonstrated with tritium labelled neutral red. Both tritium labelled and I-125 labelled toluidine blue and Se-75 labelled selenomethionine were concentrated more in hyperplastic glands than in normal glands, and the maximum selective uptake of radiolabelled toluidine blue exceeded that of Se-75-selenomethionine. In the clinical test I-131 was preferred as label since I-125 is not suitable for a gamma camera. The results were better than those obtained with Se-75-selenomethionine and represents an improvement as a radionuclide for the parathyroids. (NO)

**20156** FUNCTIONAL CONDITION OF REMOTE METASTASES OF THYROID GLAND CANCER (ACCORDING TO THE DATA OF PROFILE SCANNING). Kiseleva, E. S.; Sedrakyan, R. L.; Starinskii, V. V.; Reznichenko, F. M. (Inst. of Oncology, Moscow). Med. Radiol.; 20: No. 2, 16-22(Feb 1975). (In Russian).

The authors studied functional peculiarities of remote metastases of the thyroid gland cancer in 18 patients by means of the profile scanning method with shielding the regions of metastatic spreading into the lungs and bones by lead units. The obtained values of $T_{eff}$ in patients with metastases in the lungs and bones comprised for the whole body—4.2—0.5 of the day, for metastases—7.3—0.5 of the day. By the end of the first day the content of $^{131}$I in the affected lungs was between 8 and 61 percent. In the majority of the patients, the amount of radioactivity in the right lung was 10 to 20 percent higher than in the left one. The application of the method of profile scanning makes it possible to reveal rather clearly the main functional peculiarities of remote metastases of the thyroid gland cancer. (auth)

**20157** SIMPLE RADIONUCLIDIC TEST FOR THE PRESENCE OF BACTERIA IN BIOLOGICAL SAMPLES. Webber, C. E.; Adeniyi-Jones, C.; Bowen, B. M.; Garnett, E. S. (McMaster Univ., Hamilton, Ont.). Int. J. Nucl. Med. Biol.; 2: No. 1, 49(Jan 1975).

Large numbers of blood samples need to be screened in the diagnosis of suspected bacternemia. A simple procedure was developed for use in any laboratory with access to a liquid scintillation counter. Samples initially containing between 10 and 100 colony forming units (CFU) of Escherichia coli (ATCC 10536), Staphylococcus aureus (ATCC 9144) or Diplococcus pneumoniae (laboratory strain) were incubated in multidose vials with D-glucose-1-$^{14}$C, and the resultant count rates compared with those of control vials. The results showed that 10 CFU of E. coli or S. aureus could be detected; D. pneumoniae, which replicated slowly, gave at least 10 times background count from 50 CFU after 18 hours incubation. (UK)

**20158** GASTROINTESTINAL TRANSIT ESTIMATED BY AN ISOTOPE CAPSULE. Kirwan, W. O. (Western General Hospital, Edinburgh); Smith, A. N. Scand. J. Gastroenterol.; 9: No. 8, 763-766(1974).

An isotope capsule method of determining total gastrointestinal and colonic transit time is described. The method was validated as a means of determining transit time by comparing it with radioopaque markers. There was agreement in normals and in constipation but not in diarrhea. The effect of varying the specific gravity on the rate of transit of the isotope capsule was studied; transit was accelerated by increasing specific gravity from 1.1 to 1.35 and by reducing it to 0.93. Colonic transit was measured directly and indirectly. There was delay at the splenic flexure and rectosigmoid in constipated subjects but at the rectosigmoid only in normals. (auth)

**20159** HIGHLY SPECIFIC RADIOIMMUNOASSAY FOR SERUM ALDOSTERONE REQUIRING NO CHROMATOGRAPHIC SEPARATION. Clements, J. A. (Univ. of Manitoba, Winnipeg). Aust. J. Med. Technol.; 5: No. 3, 119-144(Aug 1974).

An aldosterone-3-carboxymethoxy-BSA conjugate, on rabbit immunization, gave a highly specific antibody to aldosterone with not more than 0.004% cross-reactivity with all relevant steroids except 18 hydroxy-DOC (0.015%). This antibody was utilized in a radioimmunoassay for aldosterone, after serum extraction with methylene chloride, in which no further purification step is necessary. A normal range was established after serum aldosterone estimations on twenty normals: ten men and ten women (age range: 18-43). Details of antigen preparation, antibody affinity

(titres) and specificity, serum extraction, and radioimmunoassay procedure are presented. Assay sensitivity, precision and accuracy are discussed. A literature review, summary, and bibliography are included. (auth)

**20160** $^{131}$I SERIAL SCANNING OVER THYROID AS A METHOD TO DIFFERENTIATE ADENOMATOUS GOITRE FROM FOLLICULLAR CARCINOMA: A PRELIMINARY REPORT. Rao, M. A. P. (All India Inst. of Medical Sciences, New Delhi). pp 185-191 of Proceedings of the Fifth Asia and Oceania Congress of Endocrinology, Chandigarh, India, January 28 to February 1, 1974. Rastogi, G. K. Chandigarh, India; Endocrine Society of India (1974).

From proceedings of the fifth Asia and Oceania Congress of Endocrinology; Chandigarh, India (28 Jan 1974).

An attempt was made to differentiate between the adenomatous goitre and follicular carcinoma of thyroid based on differences in their $^{131}$I clearances. Following $^{131}$I administration, thyroid scanning was performed at intervals, up to 15 days, commencing from 24 hours, using a digital scanner. From the digital scan data, $^{131}$I differential clearance from individual lobes was further estimated in each case. The cases that showed cold nodules were excluded from the study. Of the eight cases of goiter studied, 5 were operated subsequently for which histological evidence is available. Histologically confirmed adenomata were found to exhibit a delayed clearance of $^{131}$I as compared with that of the rest of the normal thyroid. The nodular areas of follicular carcinoma showed rapid $^{131}$I clearance as compared with the rest of the normal parenchyma or that of adenomatous goiter. The results suggest that $^{131}$I serial scanning may serve as a useful preoperative diagnostic tool to differentiate between nonmalignant goiter and thyroid cancer. (auth)

**20161** VALUES OF EFFECTIVE RENAL PLASMA FLOW DETERMINED BY PAH AND I HIPPURIC CLEARANCE. Mitrov, G.; Dimitrova, S.; Musmov, D.; Salambasev, L. Acta Med. Bulg.; 1: No. 2, 41-44(1973).

Results are reported for comparative measurements of effective renal plasma flow (ERPF) by long-term PAH infusion and a single injection of $^{131}$I-hippuran in 30 patients with renal diseases. ERPF values determined by the $^{131}$I-hippurase single-shot technique ($x \pm 546.3$) were higher than the values obtained by the PAH clearance technique ($x = 441 \pm 47.3$). The differences are statistically significant ($p < 0.05$). The correlation quotient between the two methods amounts to 0.89. The regression curve is defined by the equation curve $y = -22.8 + 0.85\,x$ at a standard assessment error $S_y = 75.36$. Taking into consideration the standard assessment error it is assumed that values lower than 525 ml/min obtained with the isotopic method present a reliable evidence of reduced ERPF. The use of the classical time-consuming PAH-clearance technique may therefore be avoided, unless the absolute ERPF value should be known. (Abstr. Bulg. Sci. Med. Lit.)

# MATERIALS

**20162** (AECL-5014) CHEMISTRY AND MATERIALS DIVISION PROGRESS REPORT, JULY 1, 1974–SEPTEMBER 30, 1974. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.) Oct 1974. 139p. (PR-CMa-30). Dep. NTIS (US Sales Only) $10.00. AECL $3.00.

Results of research conducted in the solid state branch, general chemistry branch, physical chemistry branch, materials science branch, McMaster University, Queens University and University of B. C. are reported. (JRD)

**20163** (COO-2296-7) DIFFUSIONAL CREEP OF MULTICOMPONENT SYSTEMS. Progress Report, February 1, 1974–January 31, 1975. Li, J. C. M. (Rochester, Univ., N. Y. (USA)). [nd]. Contract AT(11-1)-2296. 17p. Dep. NTIS $4.00.

As part of the study of the interaction between prismatic loops, graphs are given which show the free energy of formation of one loop in the vicinity of another. The multiple creep processes in $UO_2$ are being studied. Strain volumes and the effects of stress on defect equilibria are calculated. Equipment was constructed for penetration creep measurements; data are given for a succinonitrile single crystal. (DLC)

**20164** (RN-S-0408) BEARING RETAINER MATERIALS DEVELOPMENT. First Progress Report. Dessau, P. P. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1968. 129p. Dep. NTIS $9.50.

Tests of mechanical and physical properties and cryogenic wear were performed to qualify a replacement material for the glass-reinforced Teflon used in the NERVA turbopump bearing retainer. Materials were limited to those with resistance to gamma radiation at least one order of magnitude higher than for Teflon. Test data were also obtained on room-temperature flexural strength and specific gravity. An existing 50-mm NERVA bearing tester was redesigned and rebuilt for wear testing. Five cryogenic wear tests were conducted: the first two tests were conducted on Armalon; in the following three tests, four experimental materials were tested, of which two merit further evaluation. (83 fig, 29 tables) (auth)

**20165** (SAND-74-0073A) SANDIA LABORATORIES TECHNICAL CAPABILITIES. Materials and Processes. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1975. Contract AT(29-1)-789. 37p. Dep. NTIS $5.00.

The activities which provide the basis for the materials and processes capabilities within Sandia Laboratories are described. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs. (auth)

**20166** (UCID-16678) DT FUSION NEUTRON IRRADIATION OF BPNL MOLYBDENUM, ORNL MAGNESIUM OXIDE CRYSTAL, SLL GLASS SAMPLES, UW/LLL HIGH PURITY METALLIC FOILS, LLL OPTICAL GLASS, AND LLL COPPER TENSILE SPECIMENS. MacLean, S. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Jan 1975. Contract W-7405-eng-48. 9p. Dep. NTIS $4.00.

These samples were irradiated in the LLL Rotating Target Neutron Source from Dec. 2 to 6, 1974. The order of stacking and the distances from the source are tabulated. Dosimetry foil numbers and the measured fluences are also tabulated. (DLC)

**20167** PHYSICAL METALLURGY OF NUCLEAR FUEL ELEMENTS IN SWEDEN. Ostberg, G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Int. Met. Rev.; 19: 116-134(Sep 1974).

The first of a series of reviews on the national contribution to knowledge on the physical metallurgy of nuclear fuel elements in various countries is presented. Swedish work on the microstructure and related properties of fuel-element materials is examined against the international background with regard to its relevance to the development of nuclear power in the country. The materials are uranium metal, $UO_2$, plutonium, Zircaloy-2 and other zirconium alloys, stainless steels, nickel-base alloys, and some other special cladding materials. Achievements which may be considered as pioneer efforts of original contributions to the advancement of the technology of nuclear fuel elements are highlighted. (auth)

## Ceramics and Cermets

*Refer also to abstracts 19261, 19275, 19332, 19335–19347, 19350, 20251–20253, 20259, 20261, 20265, 20313, 20392, 20394, 20397, 21419 and 21422.*

**20168** (AD-776420) RADIATION EFFECTS ON SEMICONDUCTOR MATERIALS AND DEVICES. Final Report, May–November 1973. Srour, J. R.; Curtis, O. L.; Othmer, S.; Chiu, K. Y.; Deokar, V. D. (Northrop Research and Technology Center, Hawthorne, Calif. (USA)). Dec 1973. Contract DAAG39-73-C-0171. 276p. (NRTC-73-46R). NTIS $6.75.

Results of analytical studies are presented along with results of studies on semiconductor devices, Si, $SiO_2$, Al compounds, oxides, solar cells, neutron reactions, gamma radiation, charge transfer, recombination reactions, ionizing radiation, and translators. (JRD)

**20169** (AD-779058) INVESTIGATION OF BORON CARBIDE RIBBON-REINFORCED TITANIUM COMPOSITES. Final Report, 3 February 1973–2 February 1974. Hordon, M. J. (Cabot Corp., Billerica, Mass. (USA)). 29 Mar 1974. Contract N62269-73-C-0306. 55p. NTIS $3.75.

Boron carbide ribbon-reinforced titanium composites were fabricated by a masked deposition and lamination process. $B_4C$ content was varied in the range 20 to 40 percent, and the ribbon width/thickness (W/T) ratio was varied from 120 to 2000. Matrix alloys investigated included un-alloyed Ti and Ti-6Al-4V. The mechanical behavior was examined in the temperature range 70 to 900°F. Tensile strength and modulus increased with $B_4C$ content, and decreased with temperature. Effective mechanical isotropy was achieved for composites containing uniaxially aligned ribbons with a W/T ratio >325. (GRA)

**20170** (AED-CONF-74-451-001) ZIRCONIUM NITRIDE–NOW USED AS A TECHNICAL MATERIAL. Kirner, K. (Bosch (R.) G.m.b.H., Stuttgart (F. R. Germany)). 1974. 4p. (In German). (CONF-740966-1). INIS.

From annual meeting of the German Ceramic Society; Wiesbaden, F. R. Germany (30 Sep 1974).

Published in Ber. d. Dt. Keram. Ges.

The chemical preparation of ZrN, the coating of ZrN layers by plasma sprays, and the use as electrode material are dealt with. (GE)

**20171** (AGC-2275(Vol.1)) MATERIALS PROPERTIES DATA BOOK. Volume I. Introduction and Light Metals. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 30 Aug 1970. 475p. Dep. NTIS $26.75.

Data are presented on properties of NERVA Reactor materials. Information is included on Al-base alloys, Ti-base alloys, Ni-base alloys refractory metals, Fe-base alloys, fuels, moderators, graphite, ceramics, and plastics. (JRD)

**20172** (AGC-2275(Vol.1-A)) MATERIALS PROPERTIES DATA BOOK. Volume 1-A. Nickel-Base Alloys, Refractory Metals, Other Nonferrous Metals. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 30 Aug 1970. 24p. Dep. NTIS $4.25.

Data are presented on properties of Nerva Reactor materials. Information is included on Al-base alloys, Ti-base alloys, Ni-base alloys, Fe-base alloys, fuels, control materials, moderator materials, refractory materials, and plastics. (JRD)

**20173** (AGC-2275(Vol.2)) MATERIALS PROPERTIES DATA BOOK. Volume II. Ferrous Alloys. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 30 Aug 1970. 83p. Dep. NTIS $7.25.

Data are presented on properties of NERVA reactor materials. Information is included on Al-base alloys, Ti-base alloys, Ni-base alloys, refractory metals, Fe-base alloys, fuels, moderators, graphite, ceramics, and plastics. (JRD)

**20174** (AGC-2275(Vol.3)) MATERIALS PROPERTIES DATA BOOK. Volume III. Nonmetallics and Appendices. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 30 Aug 1970. 188p. Dep. NTIS $12.50.

Data are presented on properties of NERVA Reactor materials. Information is included on Al-base alloys, Ti-base alloys, Ni-base alloys, Fe-base alloys, fuels, moderators, graphite, refractory materials, and plastics. (JRD)

**20175** (ANL-AFP-3) THERMAL CONDUCTIVITY VALUES FOR ADVANCED FUELS. Interim Report. Sheth, A.; Leibowitz, L. (Argonne National Lab., Ill. (USA)). Nov 1974. Contract W-31-109-Eng-38. 12p. Dep. NTIS $4.00.

A preliminary examination was made of existing thermal conductivity and thermal diffusivity data for uranium and plutonium carbides and nitrides. An interim set of recommended values of thermal conductivity is presented for the compounds UC, UN, PuC, PuN, (U,Pu)C, and (U,Pu)N. (6 tables) (auth)

**20176** (BMI-1714) HIGH-TEMPERATURE THERMAL PROPERTIES OF SNAP-10A FUEL MATERIAL. Nelson, S. G. (Battelle Columbus Labs., Ohio (USA)). 11 Feb 1965. Contract W-7405-eng-92. 124p. Dep. NTIS $9.25.

Declassified 5 Sep 1973.

The enthalpy, specific heat, thermal diffusivity, thermal expansion, density, and thermal conductivity of as-received and of as-received and dehydrided SNAP-10A fuel material were measured or determined as a function of temperature. Also, hemispherical total-emittance data were obtained on dehydrided, dehydrided-oxidized, and dehydrided-nitrided fuel material as a function of temperature. Noteworthy in thermal-property measurements were the effects of homogenization of the dehydrided fuel on the thermal properties. Areas rich in uranium caused by segregation during the original hydriding of the fuel became less rich during exposure to elevated temperatures. Anisotropy in fuel rods was observed. Some significant differences between thermal conductivities determined in this study and thermal conductivities previously published were observed. The solubilities of carbon, nitrogen, and oxygen in the molten (dehydrided) fuel alloys were determined up to about 2200°C. Data on carbon solubilities compared well with data previously reported on the carbon solubilities in unalloyed zirconium. The melting temperatures of fuel alloys containing 1 to 4 wt % nitrogen and of pure zirconium containing 4 wt % nitrogen were found to be as much as 300°C higher than those reported for alloys in the zirconium-nitrogen system. The melting points of alloys containing oxygen agreed with literature values for the zirconium-oxygen system except at 6 and 11 wt % oxygen, where the melting points of the fuel alloy were 100°C higher. (auth)

**20177** (BMI-1716) DEVELOPMENT OF ADVANCED HIGH-TEMPERATURE NUCLEAR MATERIALS, DURING NOVEMBER 1964 THROUGH JANUARY 1965. Chubb, W.; Paprocki, S. J. (Battelle Columbus Labs., Ohio (USA)). 1 Feb 1965. Contract W-7405-eng-92. 71p. Dep. NTIS $6.75.

Declassified 31 Aug 1973.

At fuel-surface temperatures near 1300°C and burnups near 1 at. % of the uranium ($3 \times 10^{20}$ fissions per $cm^3$), hyperstoichiometric UC samples showed fractional gas releases that varied from fractional gas releases that varied from 0.1 per cent for some 100 per cent dense samples to 7.4 per cent for some 87 per cent dense samples. Metallographic measurements of porosity in the samples after irradiation showed comparable changes in density for the 100 and 92 per cent dense samples, and a trend toward a smaller change in density for the 87 per cent dense samples. At fuel-surface temperatures up to 1200°C and burnups between 1 and 2 at. % of the uranium, specimens of UN, UC alloys, and tungsten-UC cermets showed negligible porosity after irradiation. This result supports previous indications that alloying may improve the dimensional stability of UC-base fuels. Heat treatments of irradiation control specimens for 956 h at 1300°C produced minor density increases and depletion of excess carbon, establishing that density decreases observed in uranium carbides after irradiation are not the result of thermal effects alone. The mechanism of liquid-uranium formation between hyperstoichiometric uranium carbide and niobium is attributed to processes of three-component diffusion between the elements, uranium, carbon, and niobium. Liquid formation should occur between niobium and UC or $U_2C_3$ at all temperatures above 1130°C if clean metallurgical contact is achieved between the niobium and the uranium carbide. A ternary peritectic reaction, UC + tungsten = $UWC_2$ + liquid uranium, occurs in the uranium-tungsten-carbon system between 2100 and 2150°C. The solidification temperature of a ternary eutectic formed between $UO_2$, tungsten, and the tungsten-bronze, $U_xWO_3$, is between 1300 and 1325°C. This eutectic will appear in slightly oxygen-rich $UO_2$-tungsten cermets at temperatures above 1300°C. The thermodynamic activity of carbon in $U_2C_3$ has been determined to obey the relation, $\log_{10}\alpha = -1.62 + 2820/T(°K)$. Foreman's equation for relating the swelling of uranium in irradiation to the creep resistance of uranium has been successfully used for uranium momocarbide. (auth)

**20178** (BMI-1743) ANALYTICAL PREDICTION OF IRRADIATION SWELLING OF URANIUM CARBIDE UNDER MECHANICAL RESTRAINT. Leach, E. R.; Ray, J. W.; Dingee, D. A. (Battelle Columbus Labs., Ohio (USA)). 13 Sep 1965. Contract W-7405-eng-92. 48p. Dep. NTIS $5.50.

Declassified 20 Mar 1970.

Burnup-induced swelling of clad uranium carbide was calculated and the results compared favorably with experimental observations. Calculations were made for a mathematical model in which it is assumed that swelling is caused by creep-controlled growth of bubbles homogeneously distributed within the fuel material and by the introduction of solid fission products into the fuel. A computer program, BULGE, was written to perform the numerical integration of the fuel-cladding stress-strain relationships to obtain swelling as a function of irradiation conditions and material properties. BULGE results for temperatures at 1100°C and higher indicate that niobium-1 wt. % zirconium caldding offers no restraint to swelling of UC, while tungsten-26 wt. % rhenium cladding appears to provide a significant restraint to swelling of UC. (auth)

**20179** (BNWL-253) FABRICATION OF TUNGSTEN-URANIUM DIOXIDE HONEYCOMB FUEL ELEMENT STRUCTURES, MAY 1963-JULY 1965. Final Report. Drumheller, K.; Sump, K. R. (comps.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1965. 92p. (NASA-CR-54838). Dep. NTIS $7.75.

Pneumatic impaction techniques that were developed for fabricating W-$UO_2$ honeycomb fuel grids are described. The grids were fabricated from tungsten coated $UO_2$ spheres, with and without $Y_2O_3$ as a stabilizing additive. Loading methods were developed to produce a radially varying fuel ($UO_2$) concentration. Fully dense cermet grids were fabricated at a temperature of 1600°C and with an impaction pressure of 21,000 $kg/cm^2$. Several crack-free grids were fabricated using these process techniques. (auth)

**20180** (BNWL-394) BASIC BEHAVIOR AND PROPERTIES OF W-$UO_2$ CERMETS. Final Report, July 1964-November 1965. Baker, R. J.; Daniel, J. L.; Lackey, W. J.; Lobsinger, R. J.; Scott, F. A.; Snajdr, E. A.; Roake, W. E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 12 Oct 1966. Contract AT(45-1)-1830. 150p. (NASA-CR-54840). Dep. NTIS $10.50.

Declassified 28 Aug 1973.

Thermal cycling studies on cermets prepared from tungsten and $UO_2$ powder mixtures and cermets prepared using tungsten coated $UO_2$ particles are discussed. The cermets were tested in hydrogen at high temperatures to determine the effects of temperature, thermal cycling, and hydrogen pressure. Basic mechanism studies of tungsten-$UO_2$ interactions in thermally cycled cermets are also described. (auth)

**20181** (BNWL-934) FUELED-GRAPHITE STUDIES. Quarterly Progress Report, July-September 1968. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1969. Contract AT(45-1)-1830. 72p. Dep. NTIS $6.75.

Declassified 28 Aug 1973.

Research on the effects of porosity on Rover fuel and its relations with hydrogen corrosion is reported. Results of microscopic and radiographic studies are included. Results of studies on fuel coatings, radiographic examination of fuel elements fabricated with NbC particles added to the matrix, scanning electron microscopy of coating structures, and Rover graphite are also given. (JRD)

**20182** (BNWL-977) FUELED-GRAPHITE STUDIES. Quarterly Progress Report, October-December 1968. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1969. Contract AT(45-1)-1830. 30p. Dep. NTIS $4.50.

Declassified 28 Aug 1973.

Development of UC-ZrC solid-solution composite fuels for Pewee 2 reactor is reported. Results of radiographic and microscopic examinations are included. (JRD)

**20183** (BNWL-1245) QUARTERLY PROGRESS REPORT. Fueled-Graphite Studies. July, August, September, 1969. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1969. Contract AT(45-1)-1830. 26p. Dep. NTIS $4.50.

Declassified 28 Aug 1973.

Research results on graphite-carbide composite fuel elements are reported. Information and data are included on fuel samples, coating structures, matrix corrosion, and Santa Maria coke. (JRD)

**20184** (BNWL-1293) QUARTERLY PROGRESS REPORT. Fueled-Graphite Studies. October, November, December 1969. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1970. Contract AT(45-1)-1830. 23p. Dep. NTIS $4.25.

Declassified 28 Aug 1973.

Results of research on $UC_2$ hydrolysis are reported. The study involves determination of reaction kinetics using thermogravimetric and chromatographic methods. (JRD)

**20185** (BNWL-1375) FUELED-GRAPHITE STUDIES. Quarterly Progress Report, January-March 1970. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1970. Contract AT(45-1)-1830. 34p. Dep. NTIS $4.75.

Declassified 28 Aug 1973.

Results of investigations on the kinetics of $UC_2$ hydrolysis by water vapor are summarized. Results of electron microscopy studies on the microstructure of hydrolyzed $UC_2$ reaction pro-

ducts are also given. Reaction rates for $UC_2$ at 38 and 101°C and water vapor partial pressures of 28 to 55 torr were determined. (JRD)

**20186** (BNWL-1480) QUARTERLY PROGRESS REPORT, Fueled-Graphite Studies. April, May, June, 1970. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1970. Contract AT(45-1)-1830. 36p. Dep. NTIS $5.00.

Declassified 28 Aug 1973.

Results of research on kinetics of $UC_2$–water vapor reactions are reported. Hydrolysis reaction rates were determined at $UC_2$ temperatures between 49 and 101°C and water vapor partial pressures of 32.5 and 55.3 torr. The precipitated graphite on the $UC_2$ surface appears to serve as the site for initiation of the hydrolysis reaction. (JRD)

**20187** (BNWL-1612) HYDROLYSIS OF URANIUM CARBIDE FUEL BEADS. Chikalla, T. D.; Bunnell, L. R.; Woodley, R. E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1971. Contract AT(45-1)-1830. 100p. Dep. NTIS $8.00.

Declassified 28 Aug 1973.

Kinetics of hydrolysis of uranium dicarbide fuel cores were determined at 50 to 100°C and water vapor pressures of 23.8 to 75.6 torr. The fractional weight change accompanying the hydrolysis reaction was used to define the kinetics, and analysis was also made of the gaseous products accompanying the reaction. Optical and scanning electron microscopy were used to characterize the hydrolysis reaction products, and these techniques were also employed to observe the hydrolysis reaction in situ. Limited hydrolysis experiments on defected PyC-coated beads were also performed. (auth)

**20188** (BNWL-B-83) AEC REACTOR DEVELOPMENT AND TECHNOLOGY PROGRAMS. Technical Activities Quarterly Report, Octboer–December 1970. Tingey, G. L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1971. Contract AT(45-1)-1830. 12p. Dep. NTIS $4.00.

Results of research are presented on in-reactor creep of graphite, radiolytic reactions in graphite moderated reactors, fuel element dimensional stability coolant-graphite reactions, and radiation effects on fuels. (JRD)

**20189** (EURFNR-1220) QUANTITATIVE PHASE ANALYSIS IN THE U, Pu–C-SYSTEM BY X-RAY DIFFRACTION. Ganguly, C.; Vollath, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung). Sep 1974. 20p. (KFK-2049). Dep. NTIS (US Sales Only) $4.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

An absolute method is proposed for the quantitative phase analysis of mono-, di-, and sesquicarbide and dioxide in the U–Pu–C–O system by x-ray diffraction. Theoretically, the integrated intensity for the different selected lattice planes of the above phases are calculated taking into consideration the crystal structure, Lorentz polarisation factor, multiplicity factor, temperature factor, absorption factor, and unit cell volume. For the pure phase, the intensity ratios between different planes were found comparable with the corresponding measured integrated intensity ratios, thus confirming the basis of calculation. Using these calculated values and experimentally determining the corresponding integrated intensities of the x-ray diffraction pattern, any unknown carbide pellet of "U", "Pu" or "U–Pu" can be quantitatively analysed directly for mono, di, sesquicarbide and oxide phases. (15 tables) (auth)

**20190** (GEMP-12B) HIGH-TEMPERATURE MATERIALS PROGRAM. Progress Report No. 12, Part B. (General Electric Co., Cincinnati, Ohio (USA). Nuclear Materials and Propulsion Operation). 15 Jun 1962. Contract AT(40-1)-2847. 53p. Dep. NTIS $5.75.

Declassified 21 Sep 1973.

Results of research are reported on ceramic fuel elements, fuel element coatings, coated fuel particles, $UO_{2.x}$–$3Y_2O_3$ fuels, stabilization of $UO_2$, and fission product diffusion in solids. (JRD)

**20191** (GERHTR-115) METHOD OF INTEGRAL VALUES FOR MEASURING THE HEAT CONDUCTIVITY AND OTHER PARAMETER OF MATERIALS UP TO TEMPERATURES OF 2000 KELVIN. Neumann, M. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany)). Jun 1974. 118p. (In German). (Jul-1079-RB-RW). Dep. NTIS (US Sales Only) $9.00.

Thesis. Submitted to Technische Hochschule, Aachen, West Germany. Work performed under United States–German High Temperature Reactor Research Exchange Program.

For the development of new reactor materials and nuclear fuels it is important to measure the heat conductivity of the materials at high temperatures. A method has been developed and used to measure the heat conductivity of graphite and uranium carbonitrides. The method is based on measuring a set of integral values of the heat conductivity over relatively large temperature intervals and on evaluating the temperature curve of the heat conductivity by a computer program. Further parameters of the materials such as electrical conductivity and thermal expansion can be measured simultaneously. (auth)

**20192** (JUL-1079-RB-RW) METHOD OF INTEGRAL VALUES FOR MEASURING THE HEAT CONDUCTIVITY AND OTHER PARAMETER OF MATERIALS UP TO TEMPERATURES OF 2000 KELVIN. Neumann, M. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen; Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorbauelemente; Technische Hochschule Aachen (F.R. Germany)). Jun 1974. 117p. (In German). INIS.

With figs.; 16 refs.

For the development of new reactor materials and nuclear fuels it is important to measure the heat conductivity of the materials up to high temperatures. Performing the measurements, several difficulties arise. A method which avoids most of the measuring problems was developed and used to measure the heat conductivity of graphite and uranium carbonitrides. The method is based on measuring a set of integral values of the heat conductivity over relatively large temperature intervals, and on evaluating the temperature curve of the heat conductivity by a computer program. Further parameters of the materials such as electrical conductivity and thermal expansion can be measured simultaneously. (auth)

**20193** (LA-2672) ROLE OF NONDESTRUCTIVE TESTING IN THE ROVER FUEL ELEMENT PROGRAM. Blanks, B. L.; Dutli, J. W.; Finley, J. B.; Grimm, D. E.; Tenney, G. H. (Los Alamos Scientific Lab., N. Mex. (USA)). 16 Feb 1962. Contract W-7405-eng-36. 131p. Dep. NTIS $9.75.

Declassified 28 Aug 1973.

The role of nondestructive testing in the KIWI-B1 type and KIWI-B4 type fuel element development and production program is described. Emphasis has been given to the radiographic techniques used at the various inspection stations and to the jigs and fixtures designed by the group for the purpose of serving effectively on a production basis. Detailed descriptions of the gamma-counting instruments and their respective uses are also given. Because of the importance of speedy feedback of obtained data, the various technical and administrative procedures are described. The importance of dissemination of data among all the groups involved in this program is also underlined. This dissemination constitutes the basis for the establishment of specifications as far as the radiographic and gamma-counting test methods are concerned. Most of these specifications are included as well as the respective IBM code used for storing the obtained data. (auth)

**20194** (LA-2936) FABRICATION OF URANIUM-LOADED GRAPHITE FUEL ELEMENTS FOR KIWI-B4/B5 REACTORS. Martin, W. W.; Schell, D. H.; Taub, J. M.; Taylor, J. W. (Los Alamos Scientific Lab., N. Mex. (USA)). Jun 1963. Contract W-7405-eng-36. 61p. Dep. NTIS $6.25.

Declassified 27 Aug 1973.

Graphite matrix fuel elements loaded with $^{235}U$ were fabricated for the KIWI-B4/B5 type reactors, experimental nuclear rocket engines. The elements were hexagonal in cross section, about $\frac{3}{4}$ in. across the flats, about 52 in. long, and contained 19 longitudinal holes 0.093 in. in dia. They were formed by extruding a graphite mix containing $^{235}U$ in the form of oxide through a die having 19 core pins which formed the 19 holes. The extrusions were heat treated in three operations to a maximum temperature of 2350°C to cure and decompose the resin binder and convert the $UO_2$ loading to U carbides. The majority of the elements were loaded to a nominal 400 mg U/cc and had an average C density of 1.70 g/cc. The manufacturing procedure for the elements is described as well as the evolution of the extrusion die design. Discussion is also presented on the major flaws which occurred in the elements during their manufacture and steps which were taken to correct these problems. The major flaws were twist, taper, and erratic hole locations. (auth)

**20195** (RN-S-0236) FINAL TEST REPORT FOR RADIATION EFFECTS TESTS ON INSTRUMENTATION CABLES 23/R601 AND 23/R701. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 28p. Dep. NTIS $4.50.

Two radiation effects tests on instrumentation cables were conducted at the Ground Test Reactor at General Dynamics/Fort Worth in 1964. In the first test, 23/A601, four ten-foot sections of four-conductor, shielded, Rockbestos Model 0235A cable were irradiated to an integrated exposure of $1.23 \times 10^{17}$ neutrons/cm$^2$ ($E > 0.9$ MeV) and $4.7 \times 10^{10}$ ergs/gm(C) gamma radiation. Insulation resistance measurements at ambient temperatures were

taken throughout the test. With the exception of an initial decrease in resistance caused by moisture absorption, no significant reductions in insulation resistance were noted. The second test, 23/R701, was a combined radiation and temperature test with vibration after the termination of irradiation. Fifteen cables and cable connector assemblies from various sources were irradiated to integrated exposures of $4.33 \times 10^{16}$ neutrons/cm$^2$ (E > 0.9 MeV) and $1.44 \times 10^{11}$ ergs/gm(C) gamma radiation. The cable assembly temperature was cycled from −320 to +450°F every few hours throughout the test. Measurements of insulation resistance, capacitance, and connector contact resistance, were taken at ambient as well as the high and low temperatures. No change in connector contact-resistance or cable capacitance that could be correlated with radiation was noted. Most of the insulation resistances decreased with accumulated doses and then showed a marked recovery in post-radiation measurements. The vibration test had no apparent effects on the insulation resistance or cable capacitance. However, it caused severe physical damage to many of the cable assemblies and cable tie-downs. (auth)

**20196** (RN-S-0527) NERVA MATERIALS DEVELOPMENTS. Third Quarter, Contract Year 1969 (April, May and June). (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1969. 163p. Dep. NTIS $11.25.

Activities pertaining to materials and processes development for the third quarter of Contract Year 1969 are described. Topics include: statistical properties; wear and friction studies of bearings, bearing retainers, and valves; titanium hydriding; gaseous hydrogen embrittlement; and graphite composites. Activities in support of pressure vessel, nozzle, and value development are also described. (auth)

**20197** (RN-TM-0329) EVALUATION AND TESTING OF ENGINE-MOUNTED METAL-SHEATHED CABLE ASSEMBLIES. Fox, H. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 7 Apr 1966. 33p. Dep. NTIS $4.75.

Results of tests conducted to evaluate nuclear rocket engine-mounted cable assemblies are presented. Results show that except for its hygroscopic nature, high pruity magnesium oxide (MgO) offers the best dielectric qualities in sheathed cables for use in temperatures to 1800°F. Aluminum oxide ($Al_2O_3$) or beryllium oxide (BeO) is recommended for use in temperatures from 1900°F and up. Because a loaclized oxide contamination was discovered in two test specimens, an additional acceptance test has been included on all sheathed cable assemblies procured for this program. Either a radiation resistant or a non-radiation resistant seal is required on the ends of MgO insulated cable. A weldable metalized-ceramic-insulated seal is recommended for nuclear applications. For low radiation environments General Electric's #1201 Glyptol is recommended, especially when used in fields in which mixing or heating are not necessary for curing. Engine-mounted sheathed cables, heated by gamma energy, undergo changes in insulation resistance and cable capacitance. These changes will not affect transducer operation if the heating is controlled by routing and installation design to a maximum of 1200°F. (auth)

**20198** (Y-1596) PHYSICAL PROPERTIES OF NIOBIUM CARBIDE-GRAPHITE AND TANTALUM CARBIDE-GRAPHITE COMPOSITES. Masters, D. R.; Napier, J. M.; Richards, H. L.; Smith, J. H. (Oak Ridge Y-12 Plant, Tenn. (USA)). 15 Feb 1968. Contract W-7405-Eng-26. 58p. Dep. NTIS $6.00.

Variations in the process for hot pressing niobium carbide-graphite and tantalum carbide-graphite composite structures have been studied. This program was primarily concerned with metal carbide-graphite composites ranging in metal carbide concentrations between 80 and 100 weight percent. The effects of varying the fabrication temperatures, compositions, and type of metal carbide powders as related to the physical properties were investigated. (auth)

**20199** ULTRAFINE OXIDE POWDERS PREPARED BY ELECTRON BEAM EVAPORATION. II. Powder Characteristics. Ramsay, J. D. F.; Avery, R. G. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Mater. Sci.; 9: No. 10, 1689-1695 (Oct 1974).

The surface properties and microstructure of ultrafine oxide powders (including $CeO_2$, $ZrO_2$, $U_3O_8$) prepared by vapor phase condensation were examined by several techniques (electron microscopy, x-ray diffraction, nitrogen adsorption isotherms, infrared absorption of surface species). All the powders had a very small particle size (<20 nm), and gave type II adsorption isotherms—typical of nonporous adsorbents. From infrared absorption studies of water adsorbed on the surface of the oxides, an unusually relaxed and unreactive surface was indicated. The compaction and sintering characteristics of the powders were exceptional, and made them highly suited for ceramic fabrication. The contrasting behavior of an ultrafine magnesia, consisting of porous pseudomorphic agglomerates, is demonstrated. (auth)

**20200** CERMET ARTICLES. Steen, W. J.; Hill, N. A.; Allman, J. C. (to Morgan Refractories Ltd.). British Patent 1,363,006/B/. 14 Aug 1974. 2p.

A method is described for forming a protective layer on cermets used in contact with molten metals. Such a surface layer may be obtained by coating the article with a ceramic applied as a slurry, followed by drying and sintering. Alternatively, the article may be etched with acid or alkali to remove the cermet metal from the surface and thus give a surface layer of the ceramic incorporated in the cermet. Where the surface layer is obtained by coating it is desirable that the particles of the ceramic coating should have substantially the same physical characteristics as those in the cermet, so that a good sintered band is obtained. If the thermal shock resistance of the cermet is to be maintained when the surface layer is present the layer should be thin (5 to 30μ). Cermets to which the method is particularly applicable are, for example, Mo-$Al_2O_3$ and Cr-$Al_2O_3$ containing 60 to 80% metals. Suitable ceramics include $Al_2O_3$, $ZrO_2$, MgO, $ThO_2$, BeO, and spinel, depending on the intended use of the articles. Coatings may be applied by spray, dip or brush, the thickness being most easily controlled by brushing. Examples of application of the method are given. The method is particularly applicable to thermocouple sheaths. (UK)

**20201** KINETICS OF TRANSFORMATION OF WURTZITE BORON NITRIDE INTO GRAPHITE-LIKE FORM. Balan, T. R.; Kurdyumov, O. V.; Ostrovskaya, N. F.; Pilyankevich, O. M. (Inst. of Problems in Mathematics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 12, 1109-1112(Dec 1974). (In Ukrainian).

The kinetics was studied for isothermal transformation in vacuum of wurtzite boron nitride obtained by means of shock compression into graphite-like form. The experimental data are shown to be described satisfactory by the altered equation of the first order equation. The activation energy of the investigated phase transition (20 ± 5 kcal/mol) was determined from the temperature dependence of mean rate constants. (auth)

**20202** OPTICAL ABSORPTION OF DEFECTS IN $V_2O_5$ SINGLE CRYSTALS: AS-GROWN AND REDUCED $V_2O_5$. Clauws, P.; Vennik, J. (Laboratorium voor Kristallografie en Studie van de Vaste Stof, Ghent). Phys. Status Solidi (b); 66: No. 2, 553-560 (1 Dec 1974).

Absorption spectra are presented on $V_2O_5$ single crystals in the range 0.5 to 2.1 eV. From the behavior of the optical absorption upon reduction, reoxidation, and annealing it follows that two different centers are active. The bands observed at 1.25 and 1.52 eV for a polarization parallel to the a-axis (E||a) and at 1.0 eV for E||c, increase after homogeneous reduction and are attributed to oxygen vacancies. The remaining structure in the range 0.6 to 1.1 eV is influenced by annealing and quenching and is probably due to a center related with stacking faults. A possible center is the V-V pair proposed by Perlstein. (auth)

**20203** INELASTIC NEUTRON SCATTERING BY CERIUM HYDRIDES. III. Localized Vibrations of Interstitial Hydrogen in the fcc $CeH_2$ Lattice. Vorderwisch, P. (Kernforschung, Berlin); Hautecler, S. Phys. Status Solidi (b); 66: No. 2, 595-606 (1 Dec 1974).

Explicit formulas have been derived for the frequencies of the localized modes of an impurity at the octahedral interstitial sites of a fcc $CaF_2$-type structure, describing the dynamics of the host lattice by short-range central forces and assuming that the impurity interacts with the first and second neighboring atoms of the host lattice. A threefold degeneracy is predicted. A small peak observed at 74 MeV in the neutron data on $CeH_{1.98}$ is attributed to such localized modes, due to an occupation of a few percent of the octahedral sites by hydrogen atoms. A unique set of the parameter values for the coupling of the interstitial hydrogen to the atoms of the host lattice could not be derived from the position of this peak alone; a set is proposed from a comparison with the parameter values for the host lattice which have been previously determined. (auth)

**20204** HIGH TEMPERATURE NUCLEAR REACTOR FUEL. Pollock, C. B.; Scott, J. L.; Leitnaker, J. M. (to United States Atomic Energy Commission). US Patent 3,856,622. 24 Dec 1974. Filed Date 18 Apr 1972. 10p.

A nuclear fuel is described comprising a kernel containing a dispersion of a uranium compound within a carbon or graphite matrix. The kernel contains less than 0.5 weight percent oxygen and an ameba-inhibiting concentration of sulfur and at least one pyrolytic carbon coating encasing the kernel. A process for making the fuel is also described. (Official Gazette)

**20205** PREPARATION AND PROPERTIES OF CRYSTALLINE LASER OXIDE MATERIALS. Monchamp, R. R. (Tyco Labs., Inc., Waltham, MA). J. Solid State Chem.; 12: No. 3-4, 201-206 (15 Jan 1975).

Research on solid state laser material began with the discovery of laser action in ruby in 1960. Shortly thereafter, a number of other laser hosts were investigated and from this work YAG (yttrium aluminum garnet) developed as the solid state crystal laser material of the industry. Then efforts to find new materials practically ceased. The growth and properties of the various crystalline oxide laser material are presented with emphasis on YAG. The desirable properties and needs for new host materials are discussed. (auth)

**20206** OPTICAL PROPERTIES OF NEODYMIUM PENTAPHOSPHATE: A HIGH Nd-CONCENTRATION LASER MATERIAL. Tofield, B. C.; Weber, H. P.; Damen, T. C.; Liao, P. F. (Bell Telephone Labs., Holmdel, NJ). J. Solid State Chem.; 12: No. 3-4, 207-212(15 Jan 1975).

$NdP_5O_{14}$ shows only weak fluorescence quenching of the $^4F_{\frac{3}{2}}$ fluorescence in spite of the high ($\sim 4 \times 10^{21}$ per cc) $Nd^{3+}$ concentration. Aspects of the fluorescent properties are described, and the structural basis for the reduced fluorescence quenching relative to YAG:Nd and other hosts is discussed. (auth)

**20207** THERMOLUMINESCENCE AND FLUORESCENCE IN THORIA. Harvey, P. J.; Hallett, J. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Solid State Chem.; 12: No. 3-4, 219-224(15 Jan 1975).

Single crystals of nominally pure thorium dioxide were annealed for 2 h at 1400°C in an atmosphere of CO. The reduced crystals were excited using uv radiation and the resulting thermoluminescence (TL) measured in the temperature range 20 to 360°C at a heating rate of 1.5°C $s^{-1}$. The complex thermoluminescence profiles were resolved into individual bands with maxima at 219, 246, 271, 297, and 344°C. Results of the TL emission spectra measurements indicate the existence of four electron-hole recombination centers. The main emission is a sharp-line doublet at 496 and 503 nm. Ultraviolet excitation also produced visible fluorescence. Two broad bands were observed at 447 and 565 nm giving rise to blue and orange fluorescence, respectively. A sharp-line spectrum was identified with peaks at 492, 496, and 503 nm. The sharp-line fluorescence spectrum is similar to the main TL recombination center emission spectrum. The spectrum is due to $Pr^{3+}$ ions. Doping with $Ca^{2+}$ and $Y^{3+}$ greatly reduces both the thermoluminescence and the sharp-line fluorescence. The evidence suggests a model which involves hole capture by $Pr^{3+}$ ions during uv excitation and conversion to $Pr^{4+}$. Subsequent heating liberates trapped electrons which combine with the $Pr^{4+}$ ions producing excited $Pr^{3+}$ ions. These relax to the ground state by emission of characteristic radiation. (auth)

**20208** NMR ANALYSIS OF TRANSITIONS IN $VO_2$:Al. Reyes, J. M.; Segel, S. L.; Sayer, M. (Queen's Univ., Kingston, Ont.). J. Solid State Chem.; 12: No. 3-4, 298-302(15 Jan 1975).

The nuclear magnetic resonance (NMR) spectra of $^{51}V$ in $V_{1-x}Al_xO_2$ ($0 \leq x \leq 0.038$) has been determined as functions of Al concentration and temperature. The results which are in agreement with differential thermal analysis (DTA), dc electrical conductivity, and 6328 Å optical reflectance, indicate that the temperature vs Al concentration phase diagram is similar to that previously proposed for Cr-doped $VO_2$. Comparison of the asymmetry parameters ($\eta$) in the electric field gradient and the quadrupole coupling constants ($\nu_Q$) show that there exist three distinct phases below the semiconductor-to-metal (SM) transition temperature. At low Al concentrations ($x < 0.02$) and low temperatures, the structure may be identified as that of the semiconducting phase of pure $VO_2$ (Phase I). The T-phase previously reported in pure $VO_2$ is shown to be the phase occurring just below the SM transition temperature (Phase III). A previously unreported phase (Phase II) exists for $x > 0.02$ at temperatures between Phases I and III regions. (auth)

**20209** DIRECT INFRARED MEASUREMENTS OF FILAMENT TRANSIENT TEMPERATURE DURING SWITCHING IN VANADIUM OXIDE FILM DEVICES. Duchene, J. (CEN, Grenoble, France). J. Solid State Chem.; 12: No. 3-4, 303-306(15 Jan 1975).

Static and dynamic filament temperature profiles are shown in $VO_2$ film devices. The thermal switching is the consequence of the semiconductor to metal transition at 68°C arising from the fact that a conductive filament develops across the $VO_2$ device after switching. By use of an ir microscope, large temperature spikes (some hundred degrees C) at the onset of switching in the growing filament were demonstrated. This maximum transient temperature (which may be destructive) is reached a few tens of microseconds after the generation of the filament. The external circuit parameters have a strong influence on this behavior. This maximum filament temperature is related to the magnitude of the voltage drop during breakdown. (auth)

**20210** ELECTRONIC CONDUCTION IN OXIDES AT ELEVATED TEMPERATURES. Blumenthal, R. N. (Marquette Univ., Milwaukee). J. Solid State Chem.; 12: No. 3-4, 307-318(15 Jan 1975).

A brief discussion of the defect models and experimental techniques used to characterize the electrical conductivity of insulating and semiconducting oxides are presented. Emphasis is on the electronic conduction at elevated temperatures, where the oxide may be equilibrated with the ambient atmosphere. Where appropriate, typical examples of oxides are selected to emphasize (1) how information about defect structures and transport properties of the defects in oxides may be obtained from a combined analysis of different types of experimental data, and (2) some of the experimental and theoretical problems which are limiting understanding of the electronic conductivity of insulating and semiconducting oxides and their application to technology. (auth)

**20211** THERMAL EMISSION, ELECTRICAL CONDUCTIVITY, AND HALL EFFECT FOR DEFECTS STUDY AT HIGH TEMPERATURE ($T \geq 1250$°K) IN REFRACTORY OXIDES ($Y_2O_3$, $TiO_2$). Odier, P.; Baumard, J. F.; Panis, D.; Anthony, A. M. (CNRS, Orleans, France). J. Solid State Chem.; 12: No. 3-4, 324-328 (15 Jan 1975).

It is shown that information on atomic point defects in oxides, at high temperature, may be obtained from a study of thermal emission of electrons. A simple dependence of emission against oxygen pressure is observed for $Y_2O_3$ and $TiO_2$ compounds. It is stated that this new experimental method depends only on the electron concentration and not on other carriers, as electrical conductivity does. Electrical conductivity data of single crystals of $TiO_2$ (rutile) in large oxygen pressure and temperature ranges are rationalized in terms of a defect model involving ionized titanium interstitials. Preliminary results concerning Hall effect on this material are presented. (auth)

**20212** D-ELECTRONS IN CRYSTALLINE AND AMORPHOUS $V_2O_5$ AND $MoO_3$ COMPOUNDS. Sperlich, G. (Technische Hochschule, Darmstadt, Ger.). J. Solid State Chem.; 12: No. 3-4, 360-361(15 Jan 1975).

The characteristic features of electron spin resonance (ESR) spectra of nonstoichiometric $V_2O_5$ and $MoO_3$ are surveyed. (auth)

**20213** CONCENTRATION DEPENDENCE OF SUPERCONDUCTIVITY IN RUBIDIUM TUNGSTEN BRONZES. Wanlass, D. R.; Sienko, M. J. (Cornell Univ., Ithaca, NY). J. Solid State Chem.; 12: No. 3-4, 362-369(15 Jan 1975).

Rubidium tungsten bronzes of composition $Rb_xWO_3$($0.20 < x < 0.33$) have been prepared in well-defined crystalline form and examined for superconductivity by flux-expulsion techniques. An unusual double maximum with peak values in the critical temperature of 4.35°K at $x = 0.20$ and 2.90°K at $x = 0.30$ is observed. One possible explanation would be enhanced electron–phonon coupling associated with ordering of rubidium occupancy in the hexagonal tunnels. The effect of acid etching was also examined; it was concluded that an observed increase in critical temperature is not due to hydrogen replacement for rubidium as was postulated. Critical magnetic field studies indicate type II behavior consistent with the Abrikosov–Ginzburg equation. (auth)

**20214** MECHANISM OF ELECTRON TRANSPORT IN Cr-DOPED $V_2O_3$. Sinha, A. P. B. (National Chemical Lab., Poona); Chadrashekhar, G. V.; Honig, J. M. J. Solid State Chem.; 12: No. 3-4 402-405(15 Jan 1975).

Electrical conductivity, Seebeck coefficient, heat capacity, heat of transition, and high-temperature x-ray structure of $(Cr_xV_{1-x})_2O_3$ phases (with $x < 0.10$) have been studied. On the basis of these results, it is concluded that these phases are band conductors above the low-temperature tension. There is no firm evidence of a Mott-type transition. (auth)

**20215** IDEAL MODEL FOR SWITCHING IN THIN $VO_2$ FILMS. Jackson, J. L.; Shaw, M. P. (Wayne State Univ., Detroit). J. Solid State Chem.; 12: No. 3-4, 408-410(15 Jan 1975).

Analysis of an ideal model, where heat flow is restricted to one direction, results in good qualitative agreement with the current–voltage characteristics observed in materials that exhibit an abrupt increase in electrical conductivity at a critical temperature, such as $VO_2$. (auth)

**20216** DIELECTRIC PROPERTIES OF THIN $Ta_2O_5$ FILMS Martinez-Duart, J. M.; Velilla, J. L.; Albella, J. M.; Rueda, F. (Univ. Autonoma de Madrid). Phys. Status Solidi (a); 26: No. 2, 611-615(16 Dec 1974).

The dielectric properties of anodically formed $Ta_2O_5$ thin films on tantalum foils were studied at 0.1 to 100 kHz. A value of

27.9 is obtained for the dielectric constant at 1 kHz. The capacitance–frequency characteristics for the system Ta–$Ta_2O_5$–liquid electrolyte–metallic-cathode were measured. The frequency dependence for the dissipation factor D for this system is interpreted in terms of McLean's model for tantalum solid electrolytic capacitors. Values for the equivalent series resistance of oxide and electrolyte are given. Finally the variation of D with the formation voltage of the oxide for different frequencies is interpreted. (5 fig) (auth)

**20217** OPTICAL SPECTRA OF $Pr^{3+}$ IN $YAlO_3$. Arsenev, P. A.; Bienert, K. E.; Potemkin, A. V. (Inst. of Energetics, Moscow). Phys. Status Solidi (a); 26: No. 2, K113-K115(16 Dec 1974).

$Y_{0.97}$ $Pr_{0.03}$ $AlO_3$ single crystals were grown by optical zone melting in air. Absorption (400-2400 nm) and luminescence (545-1000 nm) spectra were measured at 77°K; the transitions and energy levels were identified. (DLC)

**20218** NMR STUDY OF $V_2O_5$ LATTICE DEFORMATION IN THE SEMICONDUCTOR SYSTEMS $V_2O_5$-$MoO_3$ AND $V_2O_5$-$WO_3$. Coldea, M.; Stanescu, L.; Ardelean, I. (Univ. of Cluj). Phys. Status Solidi (a); 26: No. 2, K145-K148(16 Dec 1974).

A study of the deformation of the $V_2O_5$ lattice through the substitution of $V^{5+}$ with $Mo^{6+}$ and $W^{6+}$ ions, was made by measuring the quadrupole coupling constants $e^2qQ/h$ vs composition. NMR of $^{51}V$ was used. The coupling constants increase with $MoO_3$ and $WO_3$ content, particularly for $WO_3$, and this confirms the solid solubility range. (DLC)

**20219** PROPERTIES OF BORIDES OF THE TRANSITION METALS. Gorbunov, A. E.; Tumanov, V. I. Tsvetn. Metal.; No. 11, 72-75(Nov 1974). (In Russian).

The tensile strength during bending and compression, Vickers hardness in the temperature interval from 20 to 800°C, electric resistance, normal elasticity modulus, and wear resistance under friction were studied for the borides $ZrB_2$, $CrB_2$, $Mo_2B_5$, and the tungsten solid alloys VK15 and VK6. (JSR)

**20220** USE OF SOFT X-RAY BAND SPECTRA FOR DETERMINING VALENCE/CONDUCTION BAND STRUCTURE OF TRANSITION-METAL COMPOUNDS. Fischer, D. W. (Air Force Materials Lab., Wright-Patterson AFB, OH). pp 669-712 of Band Structure Spectroscopy of Metals and Alloys. Fabian, D. J. (ed.). London; Academic Press Inc. (1973).

From proceedings of the international meeting on electronic structure of metals and alloys studied by the methods of band structure spectroscopy; Strathclyde, UK (26 Sep 1971). See CONF-710993-.

Methods of obtaining reliable band spectra and correct interpretation of these spectra in transition metal oxides, nitrides, oxyanions, and carbides are reviewed. Data and information are presented in support of a molecular orbital model which is applicable to these compounds. (JRD)

**20221** CHARACTERISTICS OF THE MAGNETIC PROPERTIES OF $V_3Si$ WITH STRUCTURAL TRANSITION. Tret'yakov, B. N.; Kodess, B. N.; Kuritsin, V. B. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 141-143 (1974). (In Russian).

In $V_3Si$ which has a maximum temperature $T_m$ for transition to the superconducting state $T_c$, the instability of the crystalline lattice leads to a structural transition at $T_m$ close to the superconducting transition. Studies on changes of the electron structure of A15 superconducting compounds during approach to $T_c$ are of importance. The magnetic susceptibility and nuclear magnetic resonance of $^{51}V$ was investigated in samples of $V_3Si$ with and without the structural transition. The temperature dependence of the magnetic susceptibility was much greater in samples with the structural transition than in samples without it. The anisotropic component of the Knight shift has a large temperature dependence in samples with structural transition. (JSR)

**20222** PHASE TRANSITION IN REACTIVELY CO-SPUTTERED FILMS OF $VO_2$–$TiO_2$. Balberg, I.; Abeles, B.; Arie, Y. (RCA Labs., Princeton, NJ). Thin Solid Films; 24: No. 2, 307-310(Dec 1974).

Films of mixed oxides of $VO_2$ and $TiO_2$ were prepared by reactive cosputtering. With the addition of $TiO_2$ to $VO_2$ the metal–non-metal resistive transition is shifted to higher temperatures and broadened considerably. In films containing more than 50 vol. % $TiO_2$ there is no evidence for the transition. (auth)

**20223** IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF METAL-CONTAINING MATERIALS BY GEL-PRECIPITATION. Marshall, A.; Holburt, G. A.; Lane, E. S. (to United Kingdom Atomic Energy Authority). British Patent 1,363,532/B/. 14 Aug 1974. 4p.

The process described comprises the following steps: (1) mixing a solution of a metal salt or salts with a gelating agent consisting of a polyacrylamide compound and a modifying agent consisting essentially of formamide, to produce a homogeneous mixture, (2) forming the mixture into drops, and (3) allowing the drops to fall into an aqueous alkaline solution so that individual drops are converted into solid gel spheres. The metal salt may be U, Th, or Pu nitrate, or a mixture of these. C is added to the mixture before forming it into drops. Additional gelating agents may be included, and the drops may be allowed to fall into the aqueous alkaline solution through a stream of $NH_3$ gas. The solid gel spheres are washed, dried, and calcined to form microspheres of nuclear reactor fuels. Examples of application of the process are described in detail. (UK)

**20224** OBSERVATION OF $YbH_2$ PRODUCED BY EVAPORATION OF YTTERBIUM METAL IN A CONVENTIONAL VACUUM COATING UNIT. Curzon, A. E.; Singh, O. (Simon Fraser Univ., Burnaby, British Columbia). J. Less-Common Metals; 39: No. 2, 227-233(Feb 1975).

When Yb was evaporated in a conventional vacuum-coating unit the thin films formed ($\lesssim$200 Å) contained orthorhombic $YbH_2$, cubic $Yb_2O_3$ and, possibly, normal face-centered cubic Yb and body-centered cubic Yb. The uncertainty with respect to the last two phases arises because these phases gave electron diffraction reflections which overlapped, within experimental error, reflections due to the first two phases. It was deduced that the amount of hcp Yb in the films was small because the 10.0 and 10.2 reflections were not observed. In thick films (~1000 Å) only fcc Yb and a trace of $YbH_2$ were observed. The results are used to support the suggestion made by Gasgnier [Gasgnier et al., J. Less-Common Metals, 34 (1974)131] that fcc phases previously attributed to thin films of Gd, Tb, Dy, Ho, Er, and Tm are, in fact, due to the dihydrides of these metals. (auth)

**20225** THERMAL STABILITY OF $U_3O_8$ IN AIR AT HIGH TEMPERATURE. Dharwadkar, S. R.; Chandrasekharaiah, M. S.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Trombay, India). J. Therm. Anal.; 7: No. 1, 219-221(Feb 1975).

Results are reported of a microthermogravimetric study of the thermal stability of $U_3O_8$ phase in air up to 1275°K. The O/U ratio decreased sharply between 770-1025°K and then gradually between 1025–1125°K. Above 1165°K, there is a second very rapid loss up to 1275°K. The entire O loss between 1165 and 1275°K is recovered on cooling to $\leq$1100°K, while that between 725 and 1100°K is not recovered. (DLC)

**20226** OXIDATION OF UNIRRADIATED URANIUM DIOXIDE BRIQUETTES MIXED WITH STEEL GRANULES. Novoselov, G. P.; Kushnikov, V. V.; Revnov, V. N. At. Energ. (USSR); 37: No. 6, 460-462(Dec 1974). (In Russian).

Optimal conditions are reported for oxidation of unirradiated uranium dioxide briquettes mixed mechanically with steel granules and for powder fuel separation as well as the iron and uranium distribution in the resulting product. (auth)

**20227** HEAT CONDUCTIVITY BETWEEN $UO_2$ CORE AND CLADDING OF FAST REACTOR FUEL ELEMENTS. Lebedev, I. G.; Golovnin, I. S.; Bagdasarov, Yu. E.; Kuz'min, V. I.; Bibilashvili, Yu. K.; Tikhomirov, B. B.; Kalashnik, G. V.; Silakov, A. S. At. Energ. (USSR); 37: No. 6, 455-459(Dec 1974). (In Russian).

Results of the investigation in fuel elements of heat conductivity between stainless steel cladding and $UO_2$ pellets under conditions of fast reactor operation are presented. The dependence of the heat conductivity factor on ⟨⟨cold⟩⟩ gap-to-fuel core diameters, linear power, and composition of the gaseous medium (argon, helium) within the fuel element has been obtained. (auth)

**20228** ELECTROPHORETIC PROCESS FOR COATING CERAMICS. Nickerson, R. F. (to Energy Research and Development Administration). US Patent 3,860,506. 14 Jan 1975. Filed date 12 Sep 1966. 12p.

The process involves deposition of a conductive coating, followed by electrophorically depositing a continuous coat of particles onto a porous, nonconductive body, with subsequent heating to convert the deposited layer into an adherent cladding on the surface of the porous body. (auth)

**20229** ACTINIDE MONONITRIDE MICROSPHERES AND PROCESS. Gens, T. A. (to Energy Research and Development Administration). US Patent 3,860,691. 14 Jan 1975. Filed date 8 Sep 1966. 6p.

Crystalline microspheres containing actinide mononitride having a density of at least 90% theoretical are prepared by converting sol-gel derived actinide oxide–carbon microspheres, which contain 1 gram atom carbon per gram atom oxygen, to

carbide in argon at about 1,600°C and thereafter converting the carbide to the actinide mononitride in nitrogen at 1,500 to 1,700°C. Alternately, the sol-gel derived actinide oxide–carbon microspheres are converted to the actinide mononitride by reacting same with nitrogen at 1,500 to 1,700°C and thereafter thermally cycling the microspheres between the first temperature and 1,000°C at least once. (Official Gazette)

**20230** SYNTHESIS OF Mo-C SILICIDES IN A ROTATING PLASMA REACTOR. Cevales, G.; Angelin, L. (Consiglio Nazionale delle Richerche, Padua (Italy). Centro di Studio sulle Reazioni alle Alte Temperature e alle Alte Pressioni). Ber. Deut. Keram. Ges.; 51: No. 9, 258-262(Sep 1974). (In German). 6 figs.; 3 tabs.; 8 refs.

A rotating reactor operating by a plasma jet and its best operative conditions are described. The study of the ternary system Mo–Si–C was performed with satisfactory results both for the phases obtained and for the reaction yield. The structure parameters of the ternary compound (about $Mo_5Si_3C$) related to the chemical composition, with particular respect on the amount of Mo, are discussed. (auth)

**20231** METAL COMPOSITES WITH DISPERSION AND SKELETON STRUCTURE FOR APPLICATION IN NUCLEAR TECHNOLOGY. Cech, B.; Splichal, K. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). Kovove Mater.; 12: No. 2, 280-293(1974). (In German).

Unlike that of composites strengthened with fibers, the structure of composites with isotropic mechanical properties is that of a continuous skeleton of the basic phase and dispersion or a skeleton of the strengthening phase. They are conveniently prepared by powder metallurgy. A description is presented of the forming of the structure of composites designed for nuclear technology applications, namely Al-$Al_2O_3$, Mg-MgO-Be, $MgF_2$, Zr-$Y_2O_3$, UC-U. Additional applications of composites depend on whether the processing and forming of the desired structure is mastered while attainment of the required properties is safeguarded. (auth)

**20232** STABILITY OF CARBIDES OF METALS OF GROUPS IV–VI DURING PROCESSING IN ARC PLASMA. Koroleva, E. B.; Petrunichev, V. A. Fiz. Khim. Obrab. Mater.; No. 6, 123-126 (1974). (In Russian).

The physical-chemical conversions during the plasma processing of a series of carbides of the transition metals of groups IV–VI, differing from each other by their thermodynamic and thermophysical properties, were studied. The carbides studied were TiC, ZrC, HfC, VC, NbC, TaC, WC, and $Cr_3C_2$. The change of the stability of the carbides in the arc plasma was analyzed as a function of the placement of the carbide-forming metal in the periodic table. The dependences of the intensity of decarbonization and the release of spherical particles on the grain dimensions of the product was studied for different carbides. (tr-auth)

**20233** STUDY OF THE EFFECT OF GAMMA-QUANTUM AND ELECTRON IRRADIATION ON THE MAGNETIC PROPERTIES OF FERRITES WITH HEXAGONAL STRUCTURE. Mamalui, Yu. A.; Ol'khovik, L. P.; Rudenko, M. I. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 11, 1909-1911(Nov 1974). (In Russian).

The effect of γ and electron irradiation on the saturation magnetism, the anisotropy constant, Curie temperature, and lattice constant of hexaferrite of the M, W, and Y type was studied. The effects of both types of radiation on the magnetic properties of the compounds studied were identical. Electron irradiation of the ferrite $Zn_2YBa$ ($Ba_2Zn_2Fe_{12}O_{22}$) in contrast to the other compounds, led to the appearance of a non-collinear structure. Those characteristics which depend on the cation distribution are the most sensitive to radiation. (tr-auth)

**20234** MASS SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF THE ThO MOLECULE. Neubet, A.; Zmbov, K. F. (Kernforschungsanlage, Juelich, Ger.). High Temp. Sci.; 6: No. 4, 303-308(Dec 1974).

The oxygen-exchange reaction ThO(g) + La(g) = Th(g) + LaO(g) was studied by a double-focusing mass spectrometer coupled with a Knudsen cell. Reaction enthalpies $\Delta H_3^0 = 14.1 \pm 4.4$ kcal/mol and $\Delta H_{r,0}^0 = 15.1 \pm 0.6$ kcal/mole were obtained by the second- and the third-law methods, respectively. The dissociation energy of the ThO molecule is $D_0^0(ThO) = 205.2 \pm 3.9$ kcal/mole. (auth)

**20235** VAPORIZATION DISSOCIATION ENERGIES OF THE MOLECULAR CARBIDES OF TITANIUM, ZIRCONIUM, HAFNIUM, AND THORIUM. Kohl, F. J.; Stearns, C. A. (Lewis Research Center, Cleveland). High Temp. Sci.; 6: No. 4, 284-302(Dec 1974).

The high-temperature vaporization of Ti–C, Zr–C, Hf–C, and Th–C was studied by the Knudsen effusion-mass spectrometric method. For each system the metal dicarbide and tetracarbide molecular species were identified in the gas phase. Second- and third-law methods were used to determine enthalpies for the reactions M(g) + 2C(s) = $MC_2$(g), and M(g) + 4C(s) = $MC_4$(g). Experimentally determined reaction enthalpies were combined with published thermodynamic data to obtain the following dissociation energies (in kJ mole$^{-1}$): $D_0^0(Ti-C_2) = 567 \pm 21$, $D_0^0(Zr-C_2) = 575 \pm 24$, $D_0^0(Hf-C_2) = 668 \pm 28$, $D_0^0(Th-C_2) = 705 \pm 22$, $D_0^0(C_2-Ti-C_2) = 1218 \pm 22$, $D_0^0(C_2-Zr-C_2) = 1289 \pm 28$, $D_0^0(C_2-Hf-C_2) = 1346 \pm 23$, and $D_0^0(C_2-Th-C_2) = 1403 \pm 23$. In addition, maximum values were established for the dissociation energies of the metal monocarbide molecules TiC, ZrC, HfC, and ThC. Thermodynamic functions used in the calculations are discussed in terms of assumed molecular structures and electronic contributions to the partition functions. The trends shown by the dissociation energies of the carbides of Group IVB are compared with those of neighboring groups and discussed in relation to the corresponding oxides and chemical bonding. (15 tables, 37 references) (auth)

**20236** ELECTRO- AND THERMOTRANSPORT OF OXYGEN AND NITROGEN IN Va-METALS. Kirchheim, R. (Stuttgart Univ. (TH) (F. R. Germany)). 6 Jun 1973. 122p. (In German). INIS.

Available from the library of Stuttgart Univ.,

The electro and thermotransport of interstitially dissolved nitrogen and oxygen in Va metals was investigated. The measured transport coefficients show the direction in which the dissolved gases wander in an electrical field and a temperature gradient. The dependence of the transport heat and the effective charge on the parameters temperature and concentration can be measured over wide ranges in Va metals. With the help of this additional information, the validity of the various atomic models can be more accurately checked than earlier. The time development of the concentration profile was experimentally as well as theoretically investigated for the electro and thermotransport. In the theoretical investigation, relationships are derived from the flow equations and the continuity equation which can be integrated with respect to time in some singular points of the sample. The solutions obtained are simple exponential laws through which the approximation of the concentration or of the concentration gradients to a stationary value is described. The relaxation times are a measure for the operation time of the stationary state. They can be calculated from the diffusion constant and from the temperature course. Experimental investigations in the Ta–O system confirmed the validity of the derived equations and they permit the calculation of the diffusion constant of oxygen in tantalum from the measured relaxation times. (GE)

**20237** CURRENT WORK ON PROPERTIES OF CERAMICS MATERIALS USED AS NUCLEAR FUELS IN THE NATIONAL ATOMIC ENERGY COMMISSION, ARGENTINA. Marticorena, J. O. (Comision Nacional de Energia Atomica, Buenos Aires). Ceram. Crist.; 12: No. 43, 45-48(May 1973). (In Spanish).

From fifth national and international congress of ceramics; Buenos Aires, Argentina (Nov 1972).

The studies on the development and optimization of ceramic fuels by the Argentine Atomic Energy Commission are reviewed. The work is focussed on three areas: materials, properties, and experimental conditions. Materials refer to the selection of materials to be studied according to the order of priorities in their use. The term properties relates to the study of the thermal conductivity, fission gases, and specifications. The phase diagram of $(UPu)O_2$ was studied. The preliminary results obtained in the study of the structural transformations under irradiation and behavior of fuels with faults are reported. (tr-INIS)

**20238** INTERACTION OF MOLYBDENUM WITH NICKEL AND CARBON. Zakharov, A. M.; Parshikov, V. G.; Shukin, A. A. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 19-24 (1973). (In Russian).

Metallographic, microhardness measurements, and determination of the temperature for the onset of melting were used to study the Mo corner of the Mo–Ni–C ternary system. Isothermal sections at 1800 and 1200°C, polythermal sections for Ni 0.2% and projections of the liquidus surface were obtained. Ni additions to Mo–C markedly lower the solidus temperature and increase the solubility of C in Mo in the solid state. (Referativnyi Zh.)

**20239** PRIMARY SECTION OF THE MOLYBDENUM–ZIRCONIUM–NICKEL–CARBON TETRAHEDRON AT NICKEL 0.2% AND TEMPERATURES OF 1800 AND 1200°C. Zakharov, A. M.; Parshikov, V. G.; Biryukova, T. A. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 24-28(1973). (In Russian).

The quaternary system of Mo–Zr–Ni–C alloys, containing Ni 0.2%, after quenching and a long anneal, was studied by microscopic and x-ray phase analyses, measurements of the temperature of onset of melting, and by microhardness measurements. Isothermal primary sections for Ni 0.2% were obtained at 1800 and 1200°C, as well as secondary sections for Ni 0.2% with Zr/C = 7.6 : 1 and for Ni 0.2 + C 0.09%. The presence of Ni 0.2% in the

Mo–Zr–C system does not effectively change the phase composition, although it somewhat increases the combined solubility of Zr and C in Mo in the solid state. (Referativnyi Zh.)

**20240** COMPARATIVE STUDY OF THE PROPERTIES OF MOLYBDENUM–CARBON AND MOLYBDENUM–CARBON–LANTHANUM ALLOYS. Alekseenko, G. N.; Biryukova, T. A.; Nerodenko, M. M.; Shchukin, A. A. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 28-32(1973). (In Russian).

The effects of microalloying with La on the properties and structure of welded joints in a Mo–C alloy were studied. The La raises the ductility of such joints and increases the stability of the bending-angle value. (Referativnyi Zh.)

**20241** PRECISE DETERMINATION OF THE BOUNDARIES OF THE PHASE REGIONS IN THE PSEUDO TERNARY TiC–WC–TaC SYSTEM. Chaporova, I. N.; Cheburaeva, R. F. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 12, 78-83(1973). (In Russian).

Metallographic and x-ray techniques were used in a study of the pseudo ternary TiC–WC–TaC system to obtain more accurate data on the phase boundaries. In this system the boundary of the single phase (Ti, W, Ta) C region at 1500°C is disposed in the region of compositions that have a constant TiC : WC ratio of 35 : 65% (by wt.-%) or 64 : 36 (mole-%). (Referativnyi Zh.)

**20242** STRUCTURE AND OTHER PROPERTIES OF SOLID SOLUTIONS OF (Ti, W, Ta)C WITH CARBON CONTENTS CLOSE TO STOICHIOMETRY. Chaporova, I. N.; Cheburaeva, R. F.; Potemkina, N. Yu.; Kuznetsova, K. F. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 12, 71-78(1973). (In Russian).

The effect was determined of TaC content in the range 0 to 50 mole % with a constant TiC/WC ratio of 35 : 65 on some metallurgical and physical properties of (Ti,W,Ta)C solid solutions. These properties included microstructure, component distribution across the grain section, the concentration dependence of the lattice constant, microhardness, micro-brittleness, Young's modulus E, and the characteristic temperature. With increase in TaC content the lattice constant, E, and the characteristic temperature increase but the values of the other properties are lowered. (Referativnyi Zh.)

**20243** COMPOSITION AND STRUCTURE OF ZIRCONIUM CARBIDE. Zhelankin, V. I.; Krylov, A. N.; Vlasov, I. A. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 12, 114-119(1973). (In Russian).

Data are provided on the effect of C content in ZrC on the lattice constant and density, and on calculations made of the proportion of vacant sites in the Zr and C sub-lattices. An anomaly in the lattice constant is reported for certain carbide compositions. The limits of ZrC homogeneity are given. (Referativnyi Zh.)

**20244** MECHANISM OF REFRACTORY MATERIALS DESTRUCTION DUE TO INTERNAL HEAT GENERATION. Bozhko, D. F.; Buglakov, V. I.; Rzyanin, B. F. Inzh.-Fiz. Zh.; 27: No. 5, 818-824(Nov 1974). (In Russian).

Zirconium carbide decomposition when affected by a thermal shock has been studied. The thermal shock was simulated by an electric power pulse with the supply frequency (1 to 10)$^3$ kW/s. The initial sample temperature was varied from 300 to 2300°K. The analysis of the decomposition products allowed particles of two kinds to be discovered: (a) particles of irregular shape and (b) particles of spherical shape being the drops of molten carbide. The results show that two possible mechanisms of decomposition exist: (1) The mechanism of decomposition due to thermal stresses which acts at low initial surface temperature and relatively low frequency power. (2) The mechanism of frequency due to liquid phase formation. A theoretical analysis of the mechanism of decomposition due to formation of liquid phase grains and local melting has been made. It is shown that at some definite relations between thermal properties of the basic material and non-uniformities, the mechanism is probable and the mean temperature of the nonuniformity may exceed the mean bulk temperature of the material. (auth)

**20245** PHASE EQUILIBRIA IN THE $CuO–TeO_2–V_2O_5$ SYSTEM. Dimitriev, Y. B.; Ivanova, Y. Y.; Marinov, M. P. (Higher Inst. of Chemical Tech., Sofia). Compt. Rend. Acad. Bulg. Sci.; 27: No. 9, 1247-1250(1974).

Results of investigations in all sections of the diagram are the basis for a version of a phase image for a part of the $CuO–TeO_2–V_2O_5$ three-component system. The regions are outlined of the primary crystallization of 8 crystal phases, two of which belong to the initial components: $TeO_2$, $2TeO_2CuO$, $TeO_2CuO$, $2TeO_2V_2O_5$, $CuOV_2O_5$, $2CuOV_2O_5$, $3CuOV_2O_5$, $V_2O_5$. The presence of three ternary invariant points is established: $E_1$ (12.5 mol% of Cu, 70.0 mol% of $TeO_2$, 17.5 mol% of $V_2O_5$) (400°C); $E_2$ (27.5 mol% of CuO, 59.0 mol% of $TeO_2$ and 13.5 mol% of $V_2O_5$) (410°C) and $E_3$ (20.0 mol% of CuO, 37.0 mol% of $TeO_2$ and 43.0 mol% of $V_2O_5$) (415°C). (auth)

**20246** SWITCHING PHENOMENA IN THE $CuO–TeO_2–V_2O_5$ SYSTEM. Dimitriev, Y. B.; Ivanova, Y. Y.; Gatev, E. M. Higher Inst. of Chemical Tech., Sofia). Compt. Rend. Acad. Bulg. Sci.; 27: No. 9, 1251-1254(1974).

An experiment was conducted to establish the kinetics of phase transition in the $CuO–TeO_2–V_2O_5$ system. Optimum glass compositions were established in this system in which the threshold and memory effects are the basis for formation of a new non-oxide phase. It was found that in $CuO–TeO_2$ binary range, a phase transition occurs in which a non-oxide phase is also formed. (JRD)

**20247** EFFECT OF ADSORBED GASES ON GAMMA-RADIATION STABILITY OF NONLINEAR SEMICONDUCTOR RESISTORS OF BLACK SILICON CARBIDE. Ribarov, S. R.; Krezhov, K. A. (Inst. of Nuclear Research and Nuclear Energy, Sofia). Compt. Rend. Acad. Bulg. Sci.; 27: No. 10, 1343-1346(1974).

Radiation effects on conductivity of these materials are reported and discussed. Results are also included on the changes in the static and differential resistances of nonlinear resistors as function of integral gamma dose. Investigation results show that thermal treatment in a hydrogen medium, on the one hand, greatly increases the conductivity of nonlinear resistors of black silicon carbide and on the other, renders them stable to gamma radiation. The parameters of varistors thermally treated in a hydrogen (gas) medium, as a function of time, are highly stable; this is true in particular of thermal treatment in argon. The effects of the change of conductivity observed in varistors which have adsorbed argon, oxygen, or nitrogen depend on the size of the gamma dose. They can be explained by the assumption that with doses of the order of $10^5$ rads the determinant processes are those connected with the radiationally stimulated absorption of gases in the contact regions of silicon carbide grains. Effects connected with the generation of volumetric defects in the structure of silicon carbide microcrystals also become noticeable when bigger doses are used. (auth)

**20248** $Pr_2O_3–W–O_2$ SYSTEM. Belyaev, I. N.; Voropanova, L. A. (Rostov-on-Don State Univ., USSR). Zh. Neorg. Khim.; 19: No. 12, 3388-3391(Dec 1974). (In Russian).

A solid-phase-reaction method was used to study the subject system in evacuated quartz ampules, in a vacuum furnace, and in air. The compounds $Pr_6WO_{12}$, $Pr_2WO_6$, $Pr_2W_2O_9$, $Pr_2W_3O_{12}$ were obtained. $Pr_6WO_{12}$ had a face-centered cubic lattice with an elementary cell parameter a = 11,000 Å; the other compounds had more complex structures. All the compounds obtained were isostructures of the corresponding compounds formed in the $Sm_2O_3–WO_3$ and $Nd_2O_3–WO_3$ systems. Within the phase triangle $Pr_2W_3O_{12}–WO_3–W$ of the $Pr_2O_3–W–O_2$ system, there was found a wide field cubic tungsten bronze of varying composition, $Pr_xWO_{3y}$ ($0.047 \leq x \leq 0.5$, $0.87 \leq y \leq 1.17$). The elementary cell parameter of the bronze obtained in the field of compositions studied varied from a = 3.77 to 3.83 Å. (tr-auth)

# Metals and Alloys

*Refer also to abstracts 20171–20174, 20196, and 20197.*

**20249** (AD-784942) NONDESTRUCTIVE TESTING OF BERYLLIUM. Runck, R. J. (Battelle Columbus Labs., Ohio (USA). Metals and Ceramics Information Center). Jul 1974. Contract DSA900-74-C-0616. 82p. (MCIC-74-22). NTIS $15.00.

Radiography with x rays is the "workhorse" as a method of nondestructively testing beryllium. It is especially capable of revealing inclusions and it can detect voids in moderately thick sections. Ultrasonic and eddy-current tests can be used to supplement liquid-penetrant tests for identification of discontinuities near the surface. Acoustic emission is a relatively new nondestructive testing technique that has proven to be useful for evaluating beryllium under load, and more extensive use of this technique is likely in the future. Holographic interferometry has been used to detect strain, and thereby identify debonds, in beryllium structures. However, the method is not especially effective with materials having high modulus of elasticity, such as beryllium, because of the high stresses necessary to produce appreciable strain. (GRA)

**20250** (AGC-2275(Vol.4)) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Part II: DRM 05 THROUGH 23, s131-DRM08-W187f4. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1971. 187p. Dep. NTIS $12.50.

Data are presented on properties of NERVA Reactor materials. Information is included on Fe-base alloys, graphite composites, Al-base alloys, Ti-base alloys, stainless steels, Ni-base alloys, and bronzes. (JRD)

**20251** (AGC-2275(Vol. 4)(Pt. 3)) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Part III: DRM 24–45. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1971. 125p. Dep. NTIS $9.25.

Data on properties of Nerva Reactor materials are presented. Information is included on properties of $Al_2O_3$, Al, Pb, graphite-B composites, stainless steels, LiH, bronze, beryllium copper, invar, monel, and transformer steel. (JRD)

**20252** (LA-5781-PR) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Report, April 1 Through June 30, 1974 and Eighth Annual Report, FY 1974. Baker, R. D. (Comp.). (Los Alamos Scientific Lab., N. Mex. (USA)). Nov 1974. Contract W-7405-eng-36. 62p. Dep. NTIS $5.45.

Research is reported on radiation effects on LMFBR fuel materials, stainless steel clad nitride fuels, and chemical analytical methods for characterization of high quality fuels, control rods and other reactor components. (JRD)

**20253** (ORNL-TM-4726) FUELS AND MATERIALS DEVELOPMENT PROGRAM. Quarterly Progress Report for Period Ending September 30, 1974. Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 201p. AT.

Research results are reported on properties of advanced neutron absorber materials, fabrication and inspection of steam generator materials, properties of LMFBR structural and component materials, and properties of LMFBR stainless steel weldments. (JRD)

**20254** (RDT-M-2-18T(12-74)) PRECIPITATION HARDENING NICKEL ALLOY BARS, FORGINGS, AND FORGING STOCK FOR HIGH-TEMPERATURE SERVICE (ASTM A 637 WITH ADDITIONAL REQUIREMENTS). (USAEC Division of Reactor Research and Development, Washington, D. C.). Dec 1974. 7p. RSO.

This standard covers material for nuclear and associated applications other than those under the jurisdiction of ASME Boiler and Pressure Vessel Code, Section III. (DLC)

**20255** (RDT-M-3-2T(12-74)) STAINLESS AND ALLOY STEEL SEAMLESS TUBES (ASME SA-213 WITH ADDITIONAL REQUIREMENTS). (USAEC Division of Reactor Research and Development, Washington, D. C.). Dec 1974. 9p. RSO.

This standard covers stainless and alloy steel tubes for nuclear and associated applications. General requirements, basis of purchase, additional requirements, application supplements, and optional provisions are included. (DLC)

**20256** (RFP-2158) URANIUM–NIOBIUM–ZIRCONIUM ALLOYS: ANNOTATED BIBLIOGRAPHY. Part I. Journal Articles, Formal Reports, and Patents. Part II. Progress Reports and Newsletters. Jackson, R. J.; Kneale, P. A. (Dow Chemical U.S.A., Golden, Colo. Rocky Flats Div.). 31 Dec 1974. Contract AT(29-1)-1106. 50p. Dep. NTIS $5.50.

An annotated bibliography (approximately 207 references) current as of September 1, 1973, was prepared on ternary uranium–niobium–zirconium alloys. Most of the materials were obtained from Nuclear Science Abstract entries and to a lesser extent from other sources. Included are a subject index, source (organizations) data, and an author index. (auth)

**20257** (RFP-2227) PLUTONIUM–GALLIUM ALLOYS: ANNOTATED BIBLIOGRAPHY. Jackson, R. J.; Kneale, P. A. (Dow Chemical U. S. A., Golden, Colo. Rocky Flats Div.). 17 Jan 1975. Contract AT(29-1)-1106. 39p. Dep. NTIS $4.00.

An annotated bibliography current as of January 1, 1974, on binary plutonium–gallium alloys was prepared from NSA entries and additional sources. Arranged in two parts, Part I–Journal Articles, Formal Reports, and Patents, contains some 115 annotated references. Part II–Progress Reports and Newsletters has some 13 references. Included are a subject index, source (organizations) data, and an author index. (auth)

**20258** (RN-S-0052(Supp.)) REVISED FINAL TEST SPECIFICATION FOR AEROSPACE SYSTEMS TEST REACTOR (ASTR) IRRADIATION TEST NO. 4. (Aerojet-General Corp., Azusa, Calif. (USA)). Sep 1964. 27p. Dep. NTIS $4.50.

A supplement is presented that reflects the changes and/or additions to the test specification originally presented in REON Report RN-S-0052 which was printed in January of 1964. The test items are bearing for the NERVA Turbopump Assembly. (auth)

**20259** (RN-S-0353) NERVA MATERIALS DEVELOPMENT, FOURTH QUARTER, CONTRACT YEAR 1966. (1 July–30 September). (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1967. 63p. Dep. NTIS $6.25.

Activities pertaining to materials and processes development for the NERVA Program during the fourth quarter of SNP-1 Contract Year 1966 are discussed. Topics include materials investigations related to turbopumps, bearings, valves, pressure vessels, nozzles, test facilities, radiation effects, design review, technical utilization, and data reporting. (auth)

**20260** (RN-S-0501) NERVA MATERIALS DEVELOPMENTS. First Quarter, Contract Year 1969 (October, November, and December). (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1969. 86p. Dep. NTIS $7.50.

Activities pertaining to materials and processes development for the first quarter of Contract Year 1969 are described. Topics include statistical properties, wear and friction, and radiation damage. Activities in support of trubopump, pressure vessel, nozzle, skirt and extension, valve, and seal development are also described. Contamination and corrosion prevention and control plans are outlined. (auth)

**20261** (RN-S-0538) NERVA MATERIALS DEVELOPMENTS FOURTH QUARTER, CONTRACT YEAR 1969 (JULY, AUGUST, AND SEPTEMBER). (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1969. 85p. Dep. NTIS $7.25.

Activities pertaining to materials and processes development for the fourth quarter of Contract Year 1969 are described. Topics include: statistical mechanical properties, physical properties, wear and friction of radiation-resistant polymers, wear and friction of value surfaces, effects of high-purity gas on Inconel 718 and Waspaloy, contamination and corrosion control, and graphite-fiber composite mechanical and physical properties. Activities in support of turbopump, pressure vessel, lines, nozzle, skirt, skirt extension, and NASS duct development are also described. A turbopump materials evaluation plan is included. (auth)

**20262** (TID/SNA-267) s131-MPMO7-W187: MATERIALS PRIORITY AND MATURITY STATUS. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 15 Feb 1971. 48p. Dep. NTIS $5.50.

Test plans, test priorities, and test status of Nerva materials are tabulated. (JRD)

**20263** (TID/SNA–272) MATERIALS AND PROCESSING DEVELOPMENT ACTIVITIES. Quarterly Progress Report, First Quarter 1971. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Feb 1971. Contract SNP-1. 161p. Dep. NTIS $11.25.

Materials and processes development activities for the first quarter of Contract Year 1971 are reported. Materials development topics include: (1) Materials Properties Data book list to classify ductile and brittle behavior of materials; (2) property-data development reports that include toughness properties of aluminum alloy (AA) 7039-T63, tensile properties of seven candidate alloys, and thermophysical properties AISI 347, AA 7039-T63, and Ti-5Al-2.5Sn ELI; (3) radiation damage effects from GTR-20C tests; (4) gaseous-hydrogen embrittlement of Ti-5Al-2.5Sn ELI; (5) improved statistical approach to developing design allowables for AA 7039 fracture toughness and fatigue; (6) planning of material test activities for CY 71 and beyond; and (7) simulated weld specimen of primary-enjector L-channel configuration utilizing the metal-inert-gas short arc weld process. Component support topics include: (1) effect of simulated braze cycle on ARMCO 22-13-5 nozzle candidate material; (2) stress corrosion susceptibility of AA 7039-T63 pressure-vessel candidate material; (3) program to establish Category-A cyclic stress intensity ($K_I$) for prime TPA rotor material Ti-5Al-2.5Sn ELI; (4) impact tensile testing of Ti-5Al-2.5Sn ELI for valve and actuator applications; (5) filler-less orbital welding of AA 6061-T6 and AISI 347 tubing for line-use evaluation; (6) fabrication of three-dimensional woven-fiber graphite nozzle extension; (7) creep and tensile testing of arc-cast and pressed-and-sintered tungsten alloyed with 25% rhenium in hydrogen at 3800 and 4000°F. (auth)

**20264** (TID/SNA-628) MATERIALS PRIORITY AND MATURITY STATUS. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 15 Feb 1971. 48p. Dep. NTIS $5.50.

Specifications for testing Nerva reactor materials are presented. Test plans are included for steels, stainless steels, Ti-base alloys, graphite, polymers, Al-base alloys, bronze, and other materials. (JRD)

**20265** (TID/SNA-717) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Part I: DRM 01–04. Volume IV. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1971. 177p. Dep. NTIS $12.00.

Data are presented on properties of Nerva Reactor materials. Information is included on properties of Ni alloys, Al alloys, stainless steels, alloy steels, Ti alloys, and non-metallic materials. (JRD)

**20266** (USC-113P23X2) MATERIALS RESEARCH ON HIGH-FIELD SUPERCONDUCTORS. Final Report. Kim, Y. B. (University of Southern California, Los Angeles (USA)). 1973. Contract AT(11-1)-113. 8p. Dep. NTIS $4.00.

Rapid quenching from the liquid state produces defect structures with small grains and rich in point defects. Such quenching produced higher critical fields in Nb–Zr and Nb–Ti. $Nb_3Sn$ in a Cu matrix was sintered successfully. Addition of Cu to $R_2Co_{17}$ (R = rare earth) was found to greatly increase the coercive force, accompanied by segregation of Cu-rich phases. (DLC)

**20267** THERMODYNAMICS OF REACTIONS OCCURRING DURING THE INTERACTION OF VANADIUM AND OXYGEN DISSOLVED IN LIQUID IRON. Mikhailov, G. G. (Chilyabinsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 10, 5-7(1974). (In Russian).

An analysis was made of experimental data reported in the literature on the reduction capacity of V in liquid iron. It was established that solutions of ferrous oxide and vanadium monoxide appear in equilibrium with the metallic melts during dissolution of Fe by V. For the reaction $VO_{\text{solid solution}} = [V] + [O]$, the equilibrium constants at 1600° was determined. The calculation results led to the conclusion that the oxides $V_2O_3$ and $FeV_2O_4$, detectable in the oxide products of the dissolution of Fe by V, are the result of eutectoid melts of solid solutions fo the lower oxides of V and Fe. (tr-auth)

**20268** FIZICHESKOYE MATERIALOVEDENIYE KARBIDOV. (Physical Study of Carbide Materials). Samsonov, G. V.; Upadkhaya, G. Sh.; Neshpor, V. S. Kiev; Izdatel'stvo Naukova Dumka (1974). 456p.

An attempt is made to describe the physical metallurgy of carbides of transition metals and lanthanides. Data on their properties are analyzed and reduced to show the physical regularities which are responsible for the character of changes in these properties, based on the features of their electronic and crystalline structures. Causes for contradiction of some of the data are analyzed. These properties include superconductivity and radiation resistance. (DLC)

**20269** ECONOMICS OF TUNGSTEN. Barbier, C. London; Metal Bulletin Books Ltd. (1971). 192p.

This updated thesis deals with the formation of the price of tungsten on the world market. It is divided into four parts: supply of tungsten; consumption; historical background to prices, 1945-69; and theory. (DLC)

## *Corrosion and Erosion*

*Refer also to abstract 19271.*

**20270** (CONF-741013-3) CORROSION STUDIES FOR THE SODIUM COOLED FAST BREEDER REACTOR PROGRAM. Schrock, S. L.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). [nd]. 16p. Dep. NTIS $4.00.

From 146th meeting of the Electrochemical Society; New York, New York, USA (13 Oct 1974).

Nickel base materials, such as Inconel 718, are used for specialized applications. Although the Fe- and Ni-base LMFBR materials are relatively inert to sodium under normal operating conditions, sufficient corrosive processes occur to warrant design compensations for minimizing material problems encountered over the 25-30 year design life. The state-of-the-art position for each of the above sodium corrosion considerations is described. Wall thinning rates are presented in a generalized form which describes corrosion in terms of temperature, purity, and velocity of the sodium. Data are given in graphical form which illustrate the extent of the surface compositional alterations of Type 316 stainless steel as a function of the conditions of sodium exposure. Methods are also presented which permit the determination of the thickness of the near surface zone of the stainless steel in which depletion to the sodium of metallic elements, such as chromium and nickel, occurs with the attendant reduction in strength and load bearing capability. Information is presented which describes prediction techniques for interstitial element (carbon and nitrogen) loss or gain rates as a function of service temperature. Typical friction coefficients and wear rates are given for several material combinations which are in sliding contact under sodium. An additional effect which is encountered when materials are immersed in sodium arises from the ability of the sodium to reduce almost all surface oxide films. In air environments these oxides not only protect materials such as stainless steels from further oxidation, but also act as lubricative films to reduce friction coefficients and wear rates. A considerable effort has been expended over the past several years in the development of low-friction coatings which are stable in sodium and would serve a similar purpose as oxide films in air. The approach taken in this effort and the progress to date are also described. (DLC)

**20271** (RD/B/N-3157) ELECTROCHEMICAL MEASUREMENT OF CARBON POTENTIAL. Part IV: Studies on Some Sodium–Steel Systems at 910K. Hobdell, M. R.; Gwyther, J. R.; Hooper, A. J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Sep 1974. 14p. Dep. NTIS (US Sales Only) $4.00.

An electrochemical carbon cell was used to monitor changes in carbon chemical potential (activity) accompanying carbon transfer from 2¼Cr–1Mo ferritic steel to AISI 316 stainless steel in liquid sodium at 910°K. The variations of carbon activity with time in the separate 2¼ Cr–1Mo steel/sodium and 316 steel/sodium systems were also investigated. (auth)

**20272** (RD/B/N-3159) EFFECT OF SODIUM CARBON ACTIVITY UPON THE CREEP FRACTURE OF STAINLESS STEEL. Charnock, W. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Aug 1974. 31p. Dep. NTIS (US Sales Only) $4.75.

Creep tests have been performed on notched and plain specimens of AISI 316 stainless steel in low and high ($0.11 < ac < 1$) carbon activity sodium at 600°C and at general section stresses of 164 to 192N/mm². The endurance of notched specimens was markedly reduced in high carbon activity sodium whereas plain specimens were relatively unaffected by the environment. The notch region extension method was applied to two specimens which had been tested in high but different sodium carbon activities. Endurance was shorter, cracks were sharper, and crack propagation was faster in the higher carbon activity case in spite of the fact that the stress was also lower. A rudimentary model is proposed in which (a) the rate of crack opening is controlled by creep in the ligament and is hence substantially independent of the environment, while (b) there is a critical crack tip displacement or strain for crack extension by a characteristic dimension, t, which is a function of crack tip carburization. Higher carbon activity reduces the critical crack tip ductility and results in a sharper, faster propagating crack. This effect of carbon activity on crack propagation might explain the reduced tertiary creep stage reported in Incoloy 800. (auth)

**20273** (SAND-74-0376) MECHANICAL BEHAVIOR OF OXIDE FREE STAINLESS STEEL SURFACES IN A LOW PRESSURE HYDROGEN ENVIRONMENT. Cuthrell, R. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 41p. Dep. NTIS $5.25.

Results are presented of an investigation of the environment-sensitive mechanical behavior of 440C stainless steel, a material which has potential for applications in the hydrogen economy. The removal of surface oxides was found to soften the material, and reversible hardening/softening was observed on absorbing/desorbing hydrogen in the metal at room temperature. The presence of small amounts of carbon monoxide in the environment was observed to halt both the absorption and the desorption of hydrogen in the steel. Expressions were derived, in terms of the material properties and taking into account the behavior of persistent surface asperities, for the treatment of contact resistance-load data. Both contact resistance and laser interference microscopic measurements gave consistent results for the surface mechanical behavior. These experiments were performed in a bakeable ultrahigh vacuum enclosure in which surfaces were contacted with precise control of environmental, surface, and mechanical variables. (auth)

**20274** (Y-1965) VARIABLES WHICH INFLUENCE THE STRESS-CORROSION CRACKING OF URANIUM–7.5 NIOBIUM–2.5 ZIRCONIUM ALLOY. Koger, J. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 28 Jan 1974. Contract W-7405-Eng-26. 21p. Dep. NTIS $4.00.

More positive electric potentials, lower pHs, increasing chloride content, and increasing stresses decrease the time to failure of uranium-7.5 wt % niobium-2.5 wt % zirconium alloy (mulberry). Increasing amounts of chlorides increase the general corrosion rate of mulberry. In chloride solutions and above the yield stress, all failure times are short regardless of the chloride content, pH, or potential. (auth)

**20275** CORROSION RESISTANCE OF ELECTRODEPOSITED NICKEL–MOLYBDENUM AND NICKEL–TUNGSTEN ALLOYS AFTER A LIMITED CHROMIZING TREATMENT. Kinh, V. Q.; Saurat, M.; Chassaing, E.; Montuelle, J. Galvano-Organo; 43: No. 442, 271-275(Mar 1974). (In French).

The resistance to corrosion of electrodeposited Ni–Mo and Ni–W alloys was improved when plated from sulphanate baths

under suitable conditions as determined from a study of internal stress. Thick, noncracked multilayer deposits were investigated. Improved corrosion resistance was obtained by Cr diffusion of the deposits, especially to oxidizing acids and reducing agents. The deposits are hard and can be passivated. (Metals Abstr.)

**20276** WEAR RESISTANCE OF DIFFUSION BORIDE COATINGS IN VACUUM AND GASEOUS MEDIA. Golego, N. N.; Epik, A. P.; Derkach, V. D.; Labunets, V. F. Prot. Coatings Metals (USSR) (Engl. Transl.); 5: 257-260(1973).

A study was made to determine the effect of the slip rate on friction and wear of borided medium-C steel in vacuum and in air. With relatively low slip rates, both in vacuum and in air, brittle fracture and galling of the boride case and of the hardened substrate were observed. Increasing the slip rate in vacuum is accompanied by reduction of the strength of the substrate. The boride coatings crack and individual particles are embedded in the substrate. In air, the friction of the borided surfaces is affected mainly by oxidation processes. Raising the slip rate leads to more intensive oxidation, which is accompanied by reduction of the friction coefficient and wear. It is concluded that hard boride coatings stabilize the properties due to the relatively low wear and friction coefficient, particularly at high slip rates. (Metals Abstr.)

**20277** RESISTANCE TO SCALING AND TO ABRASION OF COPPER DIFFUSION COATED WITH ALUMINUM, NICKEL, AND ZIRCONIUM. Vavilovskaya, N. G.; Timonina, L. G. Prot. Coatings Metals (USSR) (Engl. Transl.); 5: 243-246(1973).

The copper surface was alloyed by the powder method with Al, Ni, and Zr in the gaseous phase, individually and in combination (Al with Ni and Al with Zr). Microhardness, structures, and phase compositions were determined. Resistance to scaling was tested by change in weight after heating to various temperatures, and abrasion resistance was tested under rolling friction without lubrication. Results are analyzed for all combinations of coatings and it is shown that both heat and abrasion resistances are improved for all conditions. There is little effect on thermal and electrical conductivity of the Cu. (Metals Abstr.)

**20278** THERMODYNAMIC CHARACTERISTICS OF CADMIUM–LEAD LIQUID SOLUTIONS. Zabdyr, L. Arch. Hutn.; 18: No. 3, 209-226(1973). (In Polish).

Measurements of emf were carried out using concentration cells of the type $Cd|Cd^{2+}$ in KCl–LiCl eutectic | Cd–Pb in the range of concentrations 10 to 90 at. % Cd at 400 to 560°C. A straight-line relationship of emf to temperature was observed. The least-square method was used in the treatment of experimental data. The results confirmed the activity coefficient of Cd and Pb in liquid Cd to Pb solutions in the literature. Thermodynamic functions for these solutions were calculated by the Krupkowski and Wagner methods. The deficiencies and advantages of the two methods are discussed. (Metals Abstr.)

**20279** SELECTIVE ANODIC DISSOLUTION OF ZIRCONIUM, MANGANESE, AND URANIUM FROM BINARY ZINC UNDER POTENTIOSTATIC CONDITIONS. Gol'dshtein, S. L. Tr. Ural. Politekh. Inst.; No. 220, 63-66(1973). (In Russian).

Studies were made of the laws governing the selective anodic dissolution, under potentiostatic control, of Zr, Mn, and U from binary Zn alloys in an equimolar KCl–NaCl melt at 700°C. Molten Zn was used as the cathode. Optimum parameters for the process, i.e. without noticeable Zn solution occurring, are described. In this way Mn and U may be selectively extracted from the Zn alloy until their composition in the latter is reduced to ~0.05%. Zr has a lower dissolution rate. (Metals Abstr.)

**20280** DURATION OF THE POTENTIOSTATIC ANODIC DISSOLUTION OF ZIRCONIUM, MANGANESE, AND URANIUM FROM BINARY ZINC ALLOYS., Gol'dshtein, S. L.; Ishutin, A. V.; Lebedev, V. A.; Smirnov, G. B.; Bychin, V. P. Tr. Ural. Politekh. Inst.; No. 220, 59-62(1973). (In Russian).

A method is proposed for calculating the period of electrolysis in fused salts under potentiostatic conditions for the selective anodic dissolution of Zr, Mn, and U from binary Zn alloys. Good agreement between theory and practice was obtained. The kinetic parameters are given for the optimum dissolution processes. (Metals Abstr.)

**20281** ANODIC SOLUTION OF YTTRIUM FROM YTTRIUM–ZINC ALLOYS. Butorov, V. P.; Novikov, E. A.; Kiba, V. B.; Solin, M. I. Tr. Ural. Politekh. Inst.; No. 220, 82-87(1973). (In Russian).

Results are given from studies of the anodic solution of Y, and of Y from Y–Zn alloys containing Y 1 to 10% in an equimolar KCl–NaCl mixture under purified Ar at 700, 750, and 800°C. Electrolysis currents covered the range $3 \times 10^{-4}$ to 10 A. Dissolution of Y takes place at potentials close to the equilibrium value, and with valencies of 2.7 and 2.5 at 700 and 800°C respectively, whereas from the alloys, Y goes into the melt at more positive potentials, and mainly in the trivalent form. The limiting dissolution current increases with Y content in the alloy. Temperature increase in the latter also raises the dissolution potential to more positive values. (Metals Abstr.)

**20282** ELECTROLYTES FOR ANODIZATION OF MOLYBDENUM. Ikonopisov, S. (Higher Inst. for Chemical Tech., Sofia). Electrodeposition Surface Treat.; 2: No. 6, 411-418(Nov 1974).

Two new types of electrolytes are found to support the growth of insulating anodic films on Mo in addition to the two electrolytes so far reported. These are glycerol solutions of various inorganic salts and phosphate esters or orthophosphoric acid. The influence of electrolyte composition and concentration on anodization under standard conditions was studied. The phosphate esters with large molecular weight were found to possess the best anodizing ability. (auth)

**20283** CORROSION AND ANODIC DISSOLUTION BEHAVIOR OF COMMON METALS COVERED WITH ANODIC FINISHING AND RELATED SEMICONDUCTING FILMS. Vijh, A. K. (Hydro-Quebec Inst. of Research, Varennes, Quebec). Electrodeposition Surface Treat.; 2: No. 6, 461-480(Nov 1974).

In the anodic finishing of metal surfaces the two main procedures are: (1) electropolishing and (2) formation of a protective semiconducting layer. In both these processes, the semiconducting solid films of the corrosion reaction products covering the electrode play a pivotal role, not only during the anodic finishing process itself, but also during the subsequent industrial use of the finished surface. Properties of these semiconducting electrodic films such as heats of formation per equivalent and thence the band gaps (i.e. semiconductivity), covalent bond energies, and lattice energy values diagnostic of the electrostatic cohesion between the ionic species constituting the solid film lattice are briefly reviewed and their role in electropolishing and anodic dissolution delineated. Illustrative examples of anodization, electropolishing, anodic dissolution, and open-circuit corrosion are described in which solid state properties of the corrosion reaction films play a crucial role in determining the corrosion resistance of the film-covered, and thence anodically finished, metals. (auth)

**20284** EFFECT OF CALORIZING A NICKEL ALLOY ON ITS LONG-TIME STRENGTH IN CERTAIN MEDIA. Nikitin, V. I.; Grigor'eva, T. N. Fiz.-Khim. Mekh. Mater.; 10: No. 1, 7-12 (1974). (In Russian).

A study was made to determine the effectiveness of calorizing alloy EI826 in order to protect it from high-temperature oxidation and from the action of ash deposits during testing for long-time strength as well as to determine the relationship of long-time strength of the calorized alloy to the scale factor. Chemical composition of the alloy was (in wt %): 0.037 C, 14.03 Cr, 1.47 Ti, 2.24 Al, 4.06 Mo, 5.89 W, 0.16 Mn, 0.27 Si, 0.015 P, and 0.004 S, balance-Ni. It was shown that the long-time strength of the alloy exceeds 4000 hours when tested at 850°C in an ash without NaCl, but when an ash with 10% NaCl is deposited on samples, their long-time strength is 500 hours or less. The basic conclusion is that calorizing does protect EI826 samples from the effects of ash content in that samples without a calorized layer have a much less long-time strength than those which are calorized. Also, the thicker the calorized layer, the better the long-time strength. (JPRS)

**20285** OXIDATION OF METALS. Lawless, K. R. (Univ. of Virginia, Charlottesville). Rep. Progr. Phys.; 37: 231-316 (1974).

A detailed review of the principles governing the oxidation of metals is presented. The initial stage of the oxidation process involves the chemisorption of oxygen, frequently followed by dissociation and at least partial ionization. The oxygen is probably incorporated by place-exchange and surface rearrangement. Ordered surface adsorption structures occur on many metals, although amorphous structures are found on some metals. Intermediate sub-oxides or "pseudo-oxides" form prior to the formation of a stable oxide. Considerable oxygen solution occurs in some metals with the formation of internal superlattice domains and sub-oxide platelet structures. Oxide nuclei form at the surface of most metals, the density of nuclei depending on the oxidation temperature and oxygen pressure, and nucleation theory is important for understanding this behavior. The growth of continuous oxide films or scales is considered in terms of various rate-limiting processes such as anion or cation diffusion through the bulk oxide, mass or electron transport across one of the interfaces, or electron transfer processes associated with the chemisorption step. A large number of rate laws including linear, parabolic, cubic, and quartic as well as logarithmic relations have been derived. Most of these have not yet been

adequately tested with the possible exception of the Wagner parabolic law. Most of the rate laws derived seem to be satisfactory only over a very limited oxide thickness range. The importance of microstructural features of the oxide is emphasized. (auth)

**20286** USE OF CHELATING AGENTS TO RAISE THE RESISTANCE TO CORROSION OF ZIRCONIUM ALLOYS. Margulova, T. Kh.; Ryabova, L. V.; Malova, T. I. (Moscow Power Inst.). Therm. Eng. (USSR) (Engl. Transl.); 20: No. 7, 120-123(1973). Translated from Teploenergetika; 20: No. 7, 83-84(1973).

Results of corrosion tests are presented showing that the corrosion resistance of zirconium alloys is raised as a result of treating the surfaces with chelating agents, by 10 to 20% in water from which oxygen has been removed and by 30 to 40% in water containing 0.1 to 0.2 mg/kg oxygen. For loops which have zirconium alloy, stainless and pearlitic steels it is advisable to choose the chelating agent with allowance for the operation of the nuclear power plant, for example for a single loop plant in the water of which oxygen is always present the trisubstitution salt of EDTA or HEDPA should be used. For nuclear plants working on water under pressure with water-moderated water-cooled reactors in which there is virtually no oxygen due to the suppression by radioactive decomposition, it is advisable to use a disubstitution salt of EDTA or HEDPA. For a final solution to the problem of introducing the method it is necessary to check the data obtained under reactor conditions. (auth)

**20287** ANODIC DISSOLUTION OF ALLOYS OF ZIRCONIUM WITH ZINC AND MANGANESE IN A MIXED SODIUM CHLORIDE–POTASSIUM CHLORIDE MELT. Ishutin, A. V.; Nichkov, I. F.; Raspopin, S. P.; Tsepelev, G. Ya. Tr. Ural. Politekh. Inst.; No. 220, 67-72(1973). (In Russian).

The anodic dissolution of alloys of (i) Zn–Zr and (ii) Zn–Zr–Mn at $10^{-4}$–10 A/cm$^2$ in an NaCl–KCl melt at 800°C was studied. Alloys (i) contained Zr 2%, and alloys (ii) Zr 2 or 2.3 with Mn 1.1, 3.9, 6.6, 7.2, or 10.2%. With current density > 0.05 A/cm$^2$ selective anodic dissolution of Zr from (i) is not possible. With a long electrolysis period, selective dissolution of Mn from (ii) can occur as $Mn^{2+}$. The partition coefficient of Mn and Zr decreases with increase in anodic current density, and with increase in the quantity of Mn extracted from the alloy for a fixed current density. (Metals Abstr.)

**20288** INTERACTION OF THE BASE OF OXIDE CATHODES OF NICKEL–RHENIUM–LANTHANUM ALLOY WITH THE COATING. Savitskii, E. M.; Ignatov, D. V.; Tylkina, M. A.; Lazarev, E. M.; Arskaya, E. P.; Ivanova, R. S.; Ugaste, Yu. E. Fiz. Khim. Obrab. Mater.; No. 6, 65-68(1974). (In Russian).

The phase composition of coatings and intermediate layers between the coating and the base was studied by electronographic and x-radiographic methods. Micro x-ray spectral and spectral studies of the base showed that the use of the new Ni–Re–La alloy does not lead to formation of a barrier layer of compounds of the barium silicate or barium tungstate type with a high resistance during operation of the tube for 4250 h. It was observed that in the intermediate layer between coating and base precipitation of a microdisperse phase enriched in the alkaline earth metals (Ba, Ca, Sr) and the activating component La and with O and C occurred. (tr-auth)

**20289** MBRS STUDIES OF THE HIGH TEMPERATURE OXIDATION OF POLYCRYSTALLINE MOLYBDENUM: SURFACE DIFFUSION OF REACTION INTERMEDIATES. Ullman, A. Z.; Madix, R. J. (Stanford Univ., CA). High Temp. Sci.; 6: No. 4, 342-350(Dec 1974).

Oxidation of polycrystalline molybdenum was studied between 1500 and 2100°C and $10^{-6}$ to $3 \times 10^{-5}$ torr effective oxygen pressure using modulated molecular beam relaxation spectrometry (MBRS). The only oxides observed were $MoO_2$, $MoO_3$, and MoO. The phase shifts of the oxides were identical, indicating that the slowest reaction step on the surface preceded the formation of the oxide products. The product phase lag and amplitude behavior was strikingly different from that expected for reactions dominated by elementary reaction steps; it was characteristic of a surface diffusion controlled reaction. Electron micrographs showed evidence of reaction at the grain boundaries. The surface diffusion coefficient was evaluated to be $10^{-(4\pm1)}$ exp (−10 ± 5 kcal gmole$^{-1}$/RT). (9 fig) (auth)

**20290** ORIGIN OF THE CUBIC RATE LAW IN ZIRCONIUM ALLOY OXIDATION. Sabol, G. P. (Westinghouse Research Labs., Pittsburgh); Dalgaard, S. B. J. Electrochem. Soc.; 122: No. 2, 316-317(Feb 1975).

Pretransition corrosion kinetics of Zr alloys below 400°C deviate from ideal parobolic behavior, approaching cubic behavior. It is proposed that these cubic kinetics are caused by mass transfer along grain boundaries and a steadily increasing grain size of the oxide with film thickness. (DLC)

**20291** EFFECT OF THE ELECTROLYTIC POLISHING OF MOLYBDENUM ON ITS CORROSION RESISTANCE IN SULFURIC AND ORTHOPHOSPHORIC ACIDS. Yurkevich, Yu. N.; Zuev, V. N. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 100-102(1973). (In Russian).

The effect of electrolytic polishing of cold- and hot-rolled Mo on its corrosion resistance in $H_2SO_4$ and $H_3PO_4$ was studied. Electropolishing increased the resistance of Mo to corrosion in these acids. (Referativnyi Zh.)

## *Preparation and Fabrication*

**20292** (LMEC-Memo-72-2) FEASIBILITY OF WELD-REPAIRING HARDWARE CONTAINING SOLID SODIUM. Thompson, E. G. (Atomics International, Canoga Park, Calif. (USA). Liquid Metal Engineering Center). 25 Jan 1972. Contract AT(04-3)-700. 13p. AT.

An experiment is reported which demonstrated the feasibility of making weld repairs of weld or parent metal defects in components containing solid sodium. Application of the information derived to the successful repair of fillet welds in tanks containing solid sodium is described. (auth)

**20293** (N-74-17195) DEVELOPMENT OF IMPROVED ELECTROFORMING TECHNIQUE. McCandles, L. C.; Davies, L. G. (General Technologies Corp., Springfield, Va. (USA)). 1 Nov 1973. Contract NAS3-15828. 108p. (NASA-CR-134480; GTC-297). NTIS $8.50.

Techniques were studied to reinforce or strengthen electroformed nickel to allow a fuller utilization of electroforming as a reliable and low cost fabrication technique for regenerately cooled thrust chambers. Techniques for wire wrapping while electrodepositing were developed that can result in a structurally strong wall with less weight than a conventional electroformed wall. Also a technique of codepositing submicron sized $ThO_2$ particles with the nickel to form a dispersion strengthened structure was evaluated. The standard nickel cylinders exhibited an average hoop strength of 80,000 psi with a yield strength of 65,000 psi and a modulus of $25.6 \times 10$ to the 6th power psi. The as produced dispersion strengthened nickel showed a hoop strength of 97,000 psi with a yield strength of 67,000 psi. This is an increase of 17,000 psi or 21% over the standard nickel hoop strength. The wire wrapping cylinders showed an increased strength over the standard nickel test samples of 26,000 to 66,800 psi which is in the range of 26 to 104% increase in strength over the base standard nickel. These latter test results are indicative of a volume percent wire reinforcement from 15 to 31. The measured hoop strengths agree with calculated composite strengths based upon rule of mixtures. (STAR)

**20294** (N-74-30922) PROCEEDINGS OF THE SYMPOSIUM ON WELDING, BONDING, AND FASTENING, WILLIAMSBURG, VIRGINIA, MAY 30–JUNE 1, 1972. Stein, B. A.; Buckley, J. D. (comps.). (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Dec 1972. 743p. (CONF-7205113-; NASA-TM-X-70269).

Various technological processes to achieve lightweight reliable joining systems for structural elements of aircraft and spacecraft are considered. Papers presented at the symposium are concerned with selected joining techniques, spot welding, electron beam welding, weld stresses, honeycomb structures, effects of brazing, diffusion brazing, laser welding, adhesive bonding, bonding of composite materials, electroslag welding, solid state joining, nondestructive testing, riveting, explosive welding, research uses of moessbauer effect, and mechanical fasteners. (JRD)

**20295** (RD/B/N-3120) METHOD OF PRODUCING ARTIFICIAL LEAKS. Pugh, A. R.; Rowe, D. M. J.; Smith, R. J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Oct 1974. 7p. Dep. NTIS (US Sales Only) $4.00.

A method is described of preparing small artificial leaks in stainless steel material. A hole is drilled axially in a bar which is then swaged down in a hammer mill. In this process the drilled hole collapses on itself. After subsequent treatment a stable leak is produced the size of which is related to the extent of swaging. Leaks covering the range $10^{-6}$ to $10^{-2}$ torr liter per second have been produced. The long term stability of the leaks is excellent. (auth)

**20296** (RN-TM-0313) WELD PROCEDURE FOR REPAIR OF LARGE OPENING IN THE CYLINDRICAL SHELL OF VESSEL

VH-74. Flens, F. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1966. 9p. Dep. NTIS $4.00.

Recommendations for weld procedures to be used in the repair of a 5.5-in. opening in the cylindrical shell of VH-74 are presented. Welding operating conditions are outlined and quality assurance requirements are summarized. (JRD)

**20297** (RP-TR-0010) DEVELOPMENT OF IMPROVED STRENGTH LARGE HASTELLOY X FORGINGS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1966. 21p. Dep. NTIS $4.25.

The 7000- to 8000-lb size of the Phoebus-2 nozzle of Hastelloy X, closed die forgings basically exceeded the current state-of-the-art for the process and the starting material. Nevertheless, 24-in. diameter, consumable-electrode, vacuum-melted ingots were produced and were forged directly into the desired closed die configurations. The forgings were produced to meet the minimum room temperature tensile requirements of 85.0 ksi tensile strength, 40.0 ksi 0.2% offset yield strength, and 40% elongation. With product improvement as a goal, a development program was undertaken to demonstrate the practicability of improving the strength of these large forgings and to assess the effects on low temperature (−320°F) ductility. Results of the program demonstrated that, remaining within the practical shop limitations for forgings of this size, the grain size could be controlled and enhanced strength attained. Some decrease in the room temperature minimum tensile ductility occurred in the annealed condition and exposure to the nozzle brazing cycle produced only a minor change. Testing at −320°F revealed a considerable improvement in tensile ductility of the brazed material. (auth)

**20298** (TID/SNA-108) BRAZEABILITY OF HASTELLOY X STUDY. Spaletta, H. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). May 1970. 23p. Dep. NTIS $4.25.

A program to determine the brazeability of Hastelloy X material is described. The intentional additions of aluminum to Hastelloy X material as a deoxidizer during the melting process for the Phoebus II-A nozzle components resulted in a residual aluminum content of 0.3 to 0.4%. This residual amount of aluminum caused nozzle furnace brazing problems. Current AGC specifications for the Hastelloy X material control the supplier's melt practice and limit the residual aluminum content to 0.02% maximum. Production ingots as large as 10,000 lb have been produced to the new specification requirements. Brazeability tests on one-inch plate stock, rolled from these ingots, demonstrate that acceptable results can be obtained if the aluminum content does not exceed the specified amount of 0.02%. In addition to determining the brazeability of Hastelloy X material, new braze alloys and assembly procedures were evaluated. (auth)

**20299** (TID/SNA-263) BRAZEABILITY OF HASTELLOY X STUDY, 131-MA02, W141-05. Spaletta, H. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). May 1970. 22p. Dep. NTIS $4.25.

The brazeability of Hastelloy X material was investigated. The intentional additions of aluminum to Hastelloy X material as a deoxidizer during the melting process for the Phoebus II-A nozzle components resulted in a residual aluminum content of 0.3 to 0.4%. This residual amount of aluminum caused nozzle furnace brazing problems. Current AGC specifications for the Hastelloy X material control the supplier's melt practice and limit the residual aluminum content to 0.02% maximum. Ingots as large as 10,000 lb have been produced to the new specification requirements. Brazeability tests on one-inch plate stock, rolled from these ingots, demonstrate that acceptable results can be obtained if the aluminum content does not exceed the specified amount of 0.02%. In addition to determining the brazeability of Hastelloy X material, new braze alloys and assembly procedures were evaluated. (auth)

**20300** (WANL-TME-1045) DEVELOPMENT OF A BRAZING PROCESS FOR SEALING INSTRUMENTATION LEADS USING A LITHIUM BEARING BRAZE ALLOY. Laughner, E. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Dec 1964. 22p. Dep. NTIS $4.25.

Descriptions of development and qualification of a brazing process for sealing instrumentation leads in NRX reactors are presented. A Li-bearing, low-temperature silver solder capable of brazing stainless steel without a flux is used. Specifications for materials and equipment are included. (JRD)

**20301** (WANL-TME-1084) ATTACHMENT OF WELDABLE STRAIN GAGES TO STRUCTURAL PARTS. Stemann, L. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Jan 1965. 31p. Dep. NTIS $4.75.

Attachment of Microdot Weldable Strain Gages requires that joints be produced between the welding flange of the gage and the structural part being evaluated. The process control required for reliably producing these welds has been explored and process specification PS 294543-9 was written to reflect the results of the study. The welds, even though very small, represent a discontinuity which under some conditions may reduce fatigue resistance. This effect and means for eliminating it, such as material selection and plating prior to welding, have been evaluated. (auth)

**20302** TRANSMISSION SPUTTERING OF GOLD BY HEAVY IONS IN THE LOWER keV ENERGY REGION. Ecker, K. H. (Univ. of Sussex, Eng.). Radiat. Eff.; 23: No. 3, 171-180(1974).

Transmission and back-sputtering yields have been measured from epitaxially grown (100) and (111) gold single crystals of 40 to 400 Å thickness, bombarded with $Ar^+$, $Kr^+$ and $Xe^+$ ions in the energy range 250 eV to 8 keV and at target temperatures between 80 and 400°K. Combined electron microscopy and microprobe analysis (EMMA) was used to analyze the sputtered material, which was collected on thin carbon films substrates, as well as the gold films before and after bombardment. Substantial transmission sputtering is found far beyond the predicted range of the random collision cascade. Transmission sputtering yields are shown to be consistent with a model assuming channeled ions to be responsible for sputtering beyond the random range, rather than long range focused collision sequences. The experiment sets an upper limit of about 50 Å (or about 17 collision steps) for the range of a ⟨110⟩ focused collision sequence in gold, which contribute to transmission sputtering in the temperature range investigated. (auth)

**20303** SELECTION OF FINISHING PROCESSES. Safranek, W. H. Draht; 24: No. 8, 420-426(Aug 1973).

The basic function of the finishing process and its relation to the processing of the workpiece is the primary criterion in selection of a finishing method for a production scale operation. Coating systems for corrosion protection, sealing, abrasion and wear resistance, and for oxidation resistance at elevated temperatures are surveyed and compared in terms of production process requirements and production costs. Systems based on zinc, cadmium, lead, and their alloys are included in the comparative data. (Corros. Abstr.)

**20304** ANODIZING OF MOLYBDENUM IN GLYCOL–BORATE ELECTROLYTES: A PECULIAR KINETICS OF INSULATING FILM FORMATION. Ikonopisov, I. Electrodeposition Surface Treat.; 1: No. 4, 305-317(Mar 1973).

The formation of anodic films on Mo in glycol–borate electrolytes at 1.5°C over a wide range of current densities was studied. Convection in the electrolyte and visible light irradiation affected the process. In the unstirred electrolyte there is an induction period during which the electrode potential remains low and almost constant, after which it rises sharply to high values. A qualitative film formation mechanism, whereby a semiconductor film is initially formed and converted to an electronic insulator, is proposed to explain the anodic behavior of Mo. (Metals Abstr.)

**20305** VAPOR DEPOSITION OF COBALT–TUNGSTEN ALLOYS. Donaldson, J. G. (Dept. of the Interior, Rolla, MO). Electrodeposition Surface Treat.; 2: No. 6, 419-434(Nov 1974).

Cobalt–tungsten binary deposits were formed in laboratory experiments by hydrogen reduction of the anhydrous mixed vapors of cobaltous chloride and tungsten hexachloride. The materials were sublimed in separately heated zones of a reaction tube and were transported in a stream of purified helium into the deposition section of the tube where the chloride gases were reduced to metal by a countercurrent flow of hydrogen. Heat-treating of the near stoichiometric binary metallic deposits converted nearly all to the intermetallic compound $Co_3W$; however, small quantities of both cobalt and tungsten remained. Mechanical tests showed that the tensile strength of heat-treated 75% cobalt–25% tungsten deposits was twice as high as that of similarly treated deposits of cobalt. (auth)

**20306** VAPOR DEPOSITION OF MOLYBDENUM–TUNGSTEN ALLOYS. Donaldson, J. G.; Kenworthy, H. (Dept. of the Interior, Rolla, MO). Electrodeposition Surface Treat.; 2: No. 6, 435-446 (Nov 1974).

Binary alloys of molybdenum and tungsten were prepared by the Bureau of Mines in laboratory-scale experiments by hydrogen reduction of their vaporized hexafluorides. Near-optimum deposition parameters were determined and the nature of the deposited alloys was investigated. Dense, homogeneous alloys were codeposited between 650 and 750°C with a reduction efficiency of more than 75%. The alloy composition was uniform when the hydrogen ratio in the gas feed mixture did not exceed 3 times the stoichiometric requirement. Regulating the proportions of the metal hexafluorides in the gas feed provided a large degree of control over the composition of the deposit. Hardness of the deposits varied directly with the proportion of excess hydrogen in the gas feed and with the weight-

percent of tungsten in the alloy. Hardness was not affected by deposition temperature over the range of 650 to 750°C for specimens of similar composition. Extreme brittleness and unsuitable physical shapes of the alloys prevented tensile strength measurements. (auth)

**20307** FACTOR OF DEFORMATION DIVISIBILITY DURING THE DRAWING OF TUNGSTEN AND MOLYBDENUM WIRES. Severdenko, V. P.; Bryskin, B. D.; Nesgovorov, V. V. (All-Union Scientific-Research Inst. of Hard Alloys, Minsk). Dokl. Akad. Nauk BSSR; 18: No. 12, 1078-1080(Dec 1974). (In Russian).

The effect of the amount of reduction on the drawing tension, strength safety factor, and mechanical properties of W and Mo wires was studied. On the basis of the data obtained a new technology for drawing these metals in a regime of increased reduction was developed. (tr-auth)

**20308** PROCEEDINGS OF THE U. S. METALS PROCESSING AND FABRICATION SEMINAR, STRATFORD-UPON-AVON, ENGLAND, MARCH 1974. Silva, R. M. (ed.). Dayton, OH; Universal Technology Corporation (1974). vp. (CONF-740360-; ISBN-0-912426-03-9).

Papers presented at the seminar are concerned with powder metallurgy, reactive metals, electric machining, vacuum and inert atmosphere processing, precision casting, forging, electron beam welding and laser welding. (JRD)

**20309** PROCEEDINGS OF THE 3RD ELECTRON BEAM PROCESSING SEMINAR, STRATFORD-UPON-AVON, ENGLAND, MARCH 1974. Silva, R. M. (ed.). Dayton, OH; Universal Technology Corporation (1974). vp. (CONF-740359-; ISBN-0-912426-04-7).

Twenty-one papers are included which treat various topics in electron-beam processing: purification, melting, casting, machining, coating, welding, etc. Laser welding is also covered. Separate abstracts were prepared for two of the papers. (DLC)

*For abstracts of individual papers see: 20310 and 20311.*

**20310** PURIFICATION OF TANTALUM AND THE PRODUCTION OF ELECTRONIC GRADE SILICON. Tougarinoff, B. (Metallurgie Hoboken, Belgium). pp 1a1-1a8 of Proceedings of the 3rd Electron Beam Processing Seminar. Silva, R. M. (ed.). Dayton, OH; Universal Tech. Corp. (1974).

From 3rd electron beam processing seminar; Stratford-on-Avon, UK (Mar 1974). See CONF-740359-.

A short review is given of industrial practice at Metallurgie Hoboken. Electron beam melting is used to purify Ta and Si, and an attempt to use it for copper refining and casting is described. (Papers in the Melting Session are also discussed, as is the effect of the energy crisis.) (DLC)

**20311** METALLURGY OF ELECTRON BEAM WELDS. Poirier, J.; Le Roy, P.; Rapin, M. (CEA, Montrouge, France). pp 3c1-3c41 of Proceedings of the 3rd Electron Beam Processing Seminar. Silva, R. M. (ed.). Dayton, OH; Universal Tech. Corp. (1974).

From 3rd electron beam processing seminar; Stratford-on-Avon, UK (Mar 1974). See CONF-740359-.

Characteristics of the electron beam welding process are reviewed, as are the classes of weld defects (including these in alpha uranium). Unstable fracture circumstances are discussed. It is concluded that: the speed and automation of electron beam welding leads to more suitable welds, the defects limiting the weldment usefulness can be predicted, and residual stresses in the weldments have to be estimated. (35 fig) (DLC)

**20312** ELECTRODEPOSITION OF TERNARY ALLOYS OF IRON-COBALT-CADMIUM FROM THE SULPHATE BATH. Narang, S. K.; Rama Char, T. L. (Indian Inst. of Science, Bangalore). Elektron. Datenverarb.; 2: 93-107(1973).

Ternary alloys of Fe-Co-Cd were electrodeposited from the sulfate bath. Detailed studies on alloy composition, cathode efficiency, and cathode potential led to operating conditions for obtaining satisfactory deposits containing iron 0 to 60, cobalt 0 to 60, and cadmium 7 to 100%. The cathode efficiency was 39 to 99%, and the limiting current density 30 $A/dm^2$. X-ray studies indicate the presence of mixtures of the bcc and hcp phases. (auth)

**20313** BORON AND BORON CARBIDE BY VAPOR DEPOSITION. Donaldson, J. G.; Stephenson, J. B.; Cochran, A. A. (Bureau of Mines, Rolla, MO). Elektron. Datenverarb.; 2: 149-163 (1973).

$BCl_3$ can be reduced by $H_2$ at 1300°C with 85% recovery. The optimum $H_2$ to $BCl_3$ molar ratio was 30 under the test conditions used. No reaction between W substrates and the B deposits could be detected. Other substrate materials tested, in order of increasing reactivity with the depositing boron, were fused silica, mullite, graphite, Ti, and Ni. Alumina reacted extensively with the chloride gases to form aluminum chloride. When stoichiometric amounts of $BCl_3$ and $CH_4$ were reacted with an excess of $H_2$ at 1300°C, $B_4C$ deposits were obtained. An excess of $CH_4$ in the reaction mixture resulted in the codeposition of $B_4C$ and free carbon. $B_4C$ deposits contained 74.7 to 76.0% boron. The specific gravity of the $B_4C$ was 2.32, 90% theoretical. The Knoop microhardness of one $B_4C$ deposit on a mullite substrate was 3,472. A method of etching $B_4C$ was developed and used; it revealed that the $B_4C$ deposits had a columnar microstructure with the columns perpendicular to the substrate. When $BCl_3$ was reduced with $H_2$ at 1500°C with a graphite substrate, the depositing boron reacted with the graphite to produce uniform, strongly adherent coatings of $B_4C$ on graphite. The Knoop microhardness of two of these $B_4C$ coatings was 3,065 and 3,195, which corresponds to a Mohs hardness of approximately 9. (DLC)

**20314** LASER WELDING OF THIN CONDUCTORS OF REFRACTORY METALS. Uglov, A. A.; Kondrat'ev, V. A. Fiz. Khim. Obrab. Mater.; No. 6, 7-11(1974). (In Russian).

The regularities in the welding of thin conductors of W-Re alloys by laser radiation were examined. The kinetics of the formation of the weld compounds were studied by fast filming. An analysis was made of the process of formation of weld beads during various placements of the welded conductors with respect to the direction of the laser beam. (tr-auth)

**20315** GROWTH MORPHOLOGY OF THE Ni-RICH Ni-Ta-Cr-Mn SYSTEM. Piatti, G.; Dejace, J.; Fossati, C.; Matera, R. (Commission of the European Communities, Ispra, Italy). J. Mater. Sci.; 9: No. 12, 1917-1925(Dec 1974).

The solidification of an Ni-Ta-Cr-Mn alloy was investigated for a range of cooling rates and the cellular-to-dendrite transition characterized. The growth directions of the primary and secondary dendrite branches are parallel to ⟨100⟩. Microsegregation produces a white core in the dendrite interior in some growth conditions. (auth)

## *Properties, Structure, and Phase Studies*

*Refer also to abstracts 19323, 19331-19347, 19351, 19516, 21142, 21144, and 21425.*

**20316** (AD-770301) DETERMINATION OF FEASIBILITY OF APPLYING COMPUTER ANALYSIS OF TITANIUM ALLOY MICROSTRUCTURES TO QUALITY CONTROL. Final Report, 1 June 1971-16 March 1973. Dekaney, A.; Guthrie, L. E. (Mead Technology Labs., Dayton, Ohio (USA)). Aug 1973. Contract F33615-71-C-1590. 104p. (FR-73-2; AFML/TR-73-123). NTIS $4.25.

Two types of microstructure samples were examined for the Ti-6Al-2Sn-4Zr-6Mo titanium alloy under consideration. These included normal preparation of specimens and nondestructive preparation through electropolishing and replication. In total, 53 photomicrographs of alloy specimens were entered into a digital data base through digitization by the high-speed scanning device selected and purchased during the effort. The specimens were computer analyzed to establish geometric properties of primary alpha and secondary alpha particles. The 26 geometric properties were correlated with 11 mechanical properties and five heat treatment and chemical composition properties. The success in predicting ultimate tensile strength, yield strength, percent of elongation, percent reduction in area, fracture toughness, fatigue cycles to pinpoint crack indication and cycles to 1/32 inch crack for three test specimens indicates a promising future for the application of digital techniques to titanium alloy quality control. (GRA)

**20317** (AD-780911) DEFORMATION AND SOLID-SOLUTION STRENGTHENING OF bcc TITANIUM-MOLYBDENUM ALLOYS. Semiannual Report, January 1-June 1, 1974. Baggerly, R. G.; Paton, N. E.; Williams, J. C. (Rockwell International Corp., Thousand Oaks, Calif. (USA). Science Center). Jun 1974. Contract N00014-71-C-0363. 40p. NTIS $3.25.

The deformation and strengthening of bcc Ti-Mo alloys has been investigated by examining single crystals of Ti-12½ wt% Mo. A change in deformation mode from twinning to slip occurs when single phase crystals are aged to precipitate omega phase. In the single phase solution treated condition, the crystals deform by twinning. (GRA)

**20318** (AD-783337) INFLUENCE OF ENVIRONMENT ON CRACK BEHAVIOR. Interim Report. Kramer, I. R. (Martin Marietta Aerospace, Denver, Colo. (USA)). Apr 1974. Contract F44620-74-C-0032. 21p. (MCR-74-143; AFOSR-TR-74-1289). NTIS $3.00.

The analytical expressions presented relate the crack velocity and the failure time to the surface-layer stress coefficient for compact-tension specimens of Ti-6Al-4V and a 4130 steel sub-

jected to stress-corrosion cracking. The experimental data for the threshold stress intensity factor and the crack velocities for various stress intensity factors agree well with the calculated values. (auth)

**20319** (AD-785267) HIGH RESOLUTION ELECTRON MICROSCOPE STUDY OF THE OMEGA TRANSFORMATION IN Zr–Nb ALLOYS. Chang, A. L. J.; Krakow, W.; Sass, S. L. (Cornell Univ., Ithaca, N. Y. (USA). Materials Science Center). Aug 1974. Contract N00014-67-A-0077-0012. 30p. (MSC-2243). NTIS $3.25.

High-resolution direct lattice imaging and dark-field electron microscopy were used to examine the omega phase transformation in Zr–Nb alloys. In the low-Nb-content alloys, dark-field electron microscopy was used to show that the omega phase consists of large domains (100-200Å dia) made up of small particles (3-6Å dia). As the Nb content is increased, the omega domains decrease in size until only 3-5Å images are observed in alloys containing 15 wt. % Nb or more. The isolated particles are present over the range of composition from 8 to 30 wt % Nb. Time-sequence dark field micrographs taken at room temperature show that the omega domains in the low-Nb alloys are changing with time. It is suggested that these observations indicate that fluctuations in structure between the beta and omega phases are occurring at room temperature. (GRA)

**20320** (AECL-5023) CHARACTERIZATION OF DISLOCATIONS AND LARGE DISLOCATION LOOPS USING ELECTRON MICROSCOPY. Carpenter, G. J. C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Dec 1974. 21p. Dep. NTIS (US Sales Only) $4.25. AECL $0.50.

An account is presented of the experimental techniques for analyzing dislocations and loops using transmission electron microscopy. It is emphasized that care is necessary in the choice of diffraction conditions for Burgers vector analysis using the $g \cdot b = 0$ invisibility criterion. The techniques used to identify the character (vacancy or interstitial) of large dislocation loops are described in detail. Particular attention is paid to the case of perfect loops which are not of pure edge character, where appropriate orientations and diffraction vectors must be employed to obtain unambiguous results. Attention is drawn to the use of an incorrect sign convention for the characterization of imperfect, Frank loops. The measurement of loop size is discussed. (auth)

**20321** (AED-CONF-74-089-049) PHONON STATE DENSITIES OF $V_3SI$ AT DIFFERENT TEMPERATURES. Schweiss, B. P. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). 1974. 6p. (In German). (CONF-740488-1). INIS.

From meeting of the solid state physics committee of the German Physics Society; Freudenstadt, F. R. Germany (1 Apr 1974).

In order to determine the state density of lattice vibrations, the frequency distribution function of the phonons from $V_3Si$ were determined by means of incoherent inelastic neutron scattering. In addition the double differential effective cross-section was determined by using the rotating crystal time-of-flight spectrometer at the high flux reactor in Grenoble. For three scattering angles, the time-of-flight spectra are given; the scattered neutrons are sorted into time channels of 16 $\mu$sec width. The relationship between double differential effective cross-section and scattering law, the frequency distribution function found for the three temperatures (296 K; 77 K; 4.2 K), as well as comparisons of the spectra are given and discussed in detail. (GE)

**2032** (AED-CONF-74-327-003) OPTICAL PUMPING OF A DEGENERATED DISTRIBUTION OF ELECTRONS IN InSb. Bichard, R.; Lavallard, P.; Benoit a la Guillaume, C. (Ecole Normale Superieure, 75–Paris (France). Groupe de Physique des Solides). 1974. 5p. (CONF-740722-4). INIS.

From 12th international conference on the physics of semiconductors; Stuttgart, F. R. Germany (15 Jul 1974).

With abstract.

Experiments of spin orientation by optical pumping in InSb ($p = 2 \times 10^{15}$ cm$^{-3}$) with a CO laser are presented. Agreement with experimental spectra is obtained when the two spin gases are described by quasi Fermi levels and slightly different temperatures. The relevant mechanism of spin relaxation is shown to be a scattering by injected holes. (auth)

**20323** (BARC–746) VAPOR PRESSURE OF MAGNESIUM. Prasad, R.; Venugopal, V.; Iyer, P. N.; Sood, D. D. (Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.). 1974. 21p. Dep. NTIS (US Sales Only) $4.25.

Processing molten salt breeder reactor fuel involves the selective reduction of U, Pa, Pu, and fission products from the molten fluoride into liquid bismuth. A transpiration apparatus was set up and magnesium, whose vapor pressure is well established, was used for standardization for the thermodynamic investigation on alloys of interest in molten salt-liquid metal reprocessing of fuels. (MCW)

**20324** (BAW-10013-A) STUDY OF INTERGRANULAR SEPARATIONS IN LOW-ALLOY STEEL HEAT-AFFECTED ZONES UNDER AUSTENITIC STAINLESS STEEL WELD CLADDING. Ayres, P. S.; Barnes, I.; Emmanuel, G. N.; Hoosic, J. F. (Babcock and Wilcox Co., Lynchburg, Va. (USA)). Oct 1972. 72p.

Intergranular separations have been detected in the heat-affected zone of SA-508, class 2 material melted to coarse-grain practice. This observation is limited to weld cladding deposited by high heat input processes such as strip, two-wire series arc, and six-wire arc cladding. Defects occur in an area ½ inch wide, defined by the $A_3$ boundary of the heat-affected zone of the first bead, the $A_1$ boundary of the heat-affected zone of the second or overlapping bead, and the cladding/base metal interface. The dimensions of these discontinuities have not been observed to exceed 0.100 inch in depth and 0.500 inch in length. Since 0.156 inch is the maximum discontinuity depth observed throughout the industry, it is used in a fracture mechanics analysis. It was further noted that the grains of the heat-affected zones of the forgings, where the intergranular separations occurred, have coarsened to a much greater degree than the comparable heat-affected zone of plate clad by the six-wire arc cladding procedure. Results of McQuaid-Ehn studies indicated that the austenitic grain size of the forgings ranged from 1 to 4, whereas the grain size in plate material varied from 6 to 8. No intergranular separations have been observed in SA-533, grade B plate materials clad by the six-wire arc process or in single-wire, submerged-arc cladding on either forgings or plate. Metallographic examination of the heat-affected zone in the forging that exhibited the greatest propensity to intergranular separations revealed manganese-sulfide inclusions associated with the defect. This structure indicates the existence of liquation as the initiating mechanism. Intergranular separations are initiated by the liquation of low-melting-point constituents in the grain boundaries of forgings melted to coarse grain practice. Scanning electron microscopy of as-welded versus stress-relieved separations shows one mode of failure in the as-welded material and two modes in the stress-relieved material. Only a smooth fracture mode has been found in the as-welded condition, whereas, after stress-relieving, propagation of the separation occurs as a dimpled rupture type of fracture. (auth)

**20325** (BAW-10056-A) RADIATION EMBRITTLEMENT SENSITIVITY OF REACTOR PRESSURE VESSEL STEELS. Palme, H. S. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Aug 1973. 57p.

A literature survey covering the effects of residual elements on the neutron embrittlement sensitivity of pressure vessel steels shows that the copper and phosphorus contents largely control radiation embrittlement. The roles of copper, phosphorus, sulfur, vanadium, nickel, aluminum, and nitrogen were reviewed and are explained in terms of the Charpy V-notch 30 ft-lb transition temperature shift, the reduction of the Charpy upper shelf, and the increase of the yield strength. Vanadium, nickel, aluminum, and nitrogen are identified as playing minor roles in the sensitivity, and sulfur is identified as an element primarily affecting the material's initial upper shelf energy level. Through specification of the composition, B&W now uses pressure vessel steels that are predicted to be essentially insensitive to significant radiation embrittlement under normal conditions of nuclear service. Design curves for 550°F are established showing the effects of neutron fluence and of copper and phosphorus contents on the material's reference temperature, $RT_{NDT}$. (auth)

**20326** (BNWL-1151) METALLOGRAPHY OF $^{210}Po$ CONTAINING MICROSPHERES. Sump, K. R.; Beauchamp, R. H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1969. Contract AT(45-1)-1830. 22p. Dep. NTIS $4.25.

Declassified 28 Aug 1973.

Metallographic analysis was performed on hollow microspheres having layers of refractory metals and rare-earth polonide. A technique was developed for removing a metallography sample from a glove box for photographing. Photography capability in the glove box was later obtained and used. (auth)

**20327** (CEA-R-4593) STUDY OF SOME PROPERTIES OF POINT DEFECTS IN GRAIN BOUNDARIES. Martin, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Div. de Metallurgie et d'Etude des Combustibles Nucleaires). Oct 1974. 97p. (In French). Dep. NTIS (U. S. Sales Only) $8.00.

Thesis. Submitted to Paris Univ., Orsay, France.

With the aim of deducing simple information on the grain boundary core structure, an investigation was conducted of self diffusion under hydrostatic pressure, impurity diffusion (In and Au), electromigration (Sb) along certain types of grain boundaries in Ag

bicrystals, and the Mössbauer effect of $^{57}Co$ located in the grain boundaries of polycrystalline Be. Results lead to the following conclusions: the formation of vacancy-like defects is necessary to grain boundary diffusion; solute atoms may release most of their elastic energy of dissolution as they segregate at the boundary; in an electrical field, the drift of Sb ions parallel to the boundary takes place toward the anode as in the bulk. The force on the grain boundary ions is larger than in the bulk; Mössbauer spectroscopy revealed the formation of Co rich aggregates, which may prove important in the study of early stages of grain boundary precipitation. (auth)

**20328** (COO-3158-39) DEFECTS IN METAL CRYSTALS. Progress Report, May 1, 1974–April 30, 1975. Balluffi, R. W.; Seidman, D. N. (Cornell Univ., Ithaca, N. Y. (USA)). 1974. Contract AT(11-1)-3158. 35p. Dep. NTIS $4.75.

Attention was focused on point defects (vacancies, interstitials, and solute atoms), line defects (dislocations), and planar defects (dislocation arrays, grain boundaries and surfaces). Progress was made in the following areas: (A) an in-situ field ion microscope study of irradiated tungsten and tungsten alloys (volume change of migration of the stage 1 self-interstitial atom, and the recovery behavior in stages I, II, and III); (B) field ion microscope observations of voids in neutron-irradiated molybdenum, (C) a field ion microscope study of the recovery mechanism for substage II in an ion-irradiated Pt–0.62 at.% Au alloy; (D) a new technique for focused collision sequence range measurements, (E) an atom-probe field ion microscope for defect studies, (F) grain boundaries in thin-film bicrystals of surface-reactive materials, (G) computerized control and data acquisition system for quenching and annealing thin metal wires, (H) special aspects of diffusion in thin films, (I) the detection of the periodic structure of high angle twist boundaries, (J) field ion microscope studies of Au, Ni, and W solute atoms in dilute Pt alloys, and (K) FIM and electrical resistivity study of vacancy defects in quenched W. (41 references) (auth)

**20329** (COO-3476-9) APPLICATIONS OF MICRODYNAMICS AND LATTICE MECHANICS TO PROBLEMS IN PLASTIC FLOW AND FRACTURE. Progress Report, January 1, 1974–December 31, 1974. Bilello, J. C.; Liu, J. M. (State Univ. of New York, Stony Brook (USA). Coll. of Engineering). 1974. Contract AT(11-1)-3476. 18p. Dep. NTIS $4.00.

Experiments on the fracture of bcc tungsten and molybdenum crystals have shown that a considerable amount of plastic relaxation occurs in these "brittle" metals at 77°K. Results obtained by etch pitting techniques indicate that as much as 50% of the measured "surface energy" is due to plastic work dissipated by dislocation activities. The fracture of hcp zinc shows high sensitivity to both testing temperature and testing speed, implying a strong influence of plasticity in the fracture of this metal at low temperatures. This is most likely responsible for the discrepancies in the results obtained by previous investigators. High frequency ultrasonic attenuation measurements in Cu and Cu–Ni alloys demonstrated the failure of existing theories to account quantitatively for this attenuation in deformed crystals. (auth)

**20330** (HEDL-TME-73-37) ACOUSTIC EVALUATION OF COLD WORK IN 316 STAINLESS STEEL TUBING AND PLATE. Trantow, R. L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1973. Contract AT(45-1)-2170. 58p. AT.

An acoustic method of evaluating the degree of cold work, expressed in terms of microhardness, has been developed for use in characterizing 316 stainless steel FFTF/LMFBR reactor fuel tubing. A definite relationship between microhardness and 12.5 to 15 MHz acoustic wave velocity was established. Variations in chemistry and grain size have little influence on this relationship; however, tubing fabrication processes have a significant effect. Either specific system calibrations or data corrections relative to fabrication process are required. To enable cold work evaluation on a high speed production test basis, a moire (interference) technique was developed for sensing the cold work-related changes in (modified) shear wave velocity. The moire technique using a process-compensated calibration procedure was successfully demonstrated. Initial studies in this program also successfully demonstrated the application of the Rayleigh critical angle technique for evaluation of cold work in 316 SS plate. (auth)

**20331** (IS-T-3470) STRUCTURE AND PROPERTIES OF STEELS THERMOMECHANICALLY PROCESSED BY IMPACT EXTRUSION. Mayer, V. F. (Iowa State Univ. of Science and Technology, Ames (USA)). Nov 1974. Contract W-7405-eng-82. 128p. Dep. NTIS $9.50.

Thesis.

Several steels (AISI 4340, 440A stainless steel, AISI 1020) were thermomechanically treated by impact extruding (strain rates $5 \times 10^3$ $s^{-1}$) their metastable austenites at various temperatures and extrusion ratios directly into a quenching medium of oil. The effectiveness of this process was assessed by comparing tensile test results of the impact extruded steel with those from the same steel given conventional heat treatment. Thermomechanical treatment using impact extrusion as the deformation process increases the strength of steel about the same amount as thermomechanical treatments using conventional deformation processes like rolling. Increases in yield strength of as much as 14% and 24% were measured for AISI 4340 and 440A respectively. These strength increases are not accompanied by significant decreases in area reduction or elongation; a result typical of thermomechanical treatments. Transmission electron micrographs of steels given both thermomechanical treatment and conventional heat treatment were compared, the austenite grain size after extrusion was observed and measured by optical microscopy, and the temperature rise due to the high strain rate deformation was calculated using measured velocity data and conservation of energy. From these data, structure property correlations were made, the primary strengthening mechanism was deduced, and the effect of the process variables was assessed. The primary strengthening mechanism was determined to be precipitated carbide particles considerably less than 100 Å in diameter. The strength increases result from the particles themselves rather than the increased dislocation density they can cause. The latter is the case for thermomechanical treatments using conventional deformation processes. (auth)

**20332** (KFK-2039) STUDIES ON TaC–HfC HARD MATERIALS WITH AND WITHOUT BINDER METALS. Scholz, B. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Material- und Festkoerperforschung; Karlsruhe Univ. (TH) (F. R. Germany). Fakultaet fuer Maschinenbau). Sep 1974. 127p. (In German). INIS.

59 figs.; 7 tabs.; 138 refs.

$TaC_{1-x}$, $(Ta_{0.8}Hf_{0.2})$ $C_{1-x}$, $(Ta_{0.6}Hf_{0.4})$ $C_{1-x}$, $(Ta_{0.4}Hf_{0.6})$ $C_{1-x}$ and $(Ta_{0.2}Hf_{0.8})$ $C_{1-x}$ and $HfC_{1-x}$ can be prepared by melting and hot-pressing. Densities of above 95% TD were reached by hot-pressing. The lattice constants of the carbides were determined and the phase boundaries of $TaHf_{1-x}$ were estimated. The highest hardness values at 20°C (MHV approximately 2,900 kp/mm²) and at higher temperatures were found in non-stoichiometric mixed carbides. The wetting measurements were carried out by using the sessile-drop-method. The angles of contact of Co and Ni on the single carbides are small, but increase on the mixed carbides. In practice the carbides were embedded in binder phases. Substoichiometric carbides with a high concentration of defects in the C-lattice react with Co and Ni by formation of new intermetallic phases. The following non-stoichiometric carbides show no reaction: $TaC_x$–Co ($x \leq 0.92$), $TaC_x$–Ni ($x \leq 0.82$). All non-stoichiometric carbides react with the binder metals, if tantalum carbide is partly or completely substituted by hafnium carbide. TaC, HfC and their mixed carbides were hot-pressed by using 5 different binder-phases (5 wt.%): Co, Ni, two alloys with high temperature strength (Co-alloy, Ni-alloy) and austenitic Cr-Ni-steel. All investigated cemented carbides show similar hardness values at high temperatures as the corresponding carbides. The progress of oxidation of the cemented carbides in air has been determined gravimetrically and shows a weight gain proportional to time. Cemented carbides with mixed carbides show a better oxidation resistance than cemented carbides with TaC or HfC. (auth)

**20333** (KFTI-74-1) PRISMATIC SLIP IN THE BERYLLIUM–COPPER ALLOY MONOCRYSTALS. Avotin, S. S.; Kapcherin, A. S.; Papirov, I. I.; Zhan-Pol, P.; Tikhinskii, G. F. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. 47p. (In Russian). INIS.

A study was carried out of the effect of copper (0.23 and 1.34 at. %) on the characteristics and mechanism of prismatic slip of beryllium in the temperature interval of 77 to 823°K. The temperature dependence of the critical shear stress ($\tau_{10\bar{1}0}$) showed a maximum near room temperature for single-crystals of Be–0.23 at. % Cu. An increase in copper content to 1.34 at. % leads to a significant increase of $\tau_{10\bar{1}0}$ and to a disappearance of the maximum on the curve of $\tau_{10\bar{1}0}$ (T). On the deformation curves of single crystals of Be–1.34 at.% Cu an increase in yield point was noted after relaxation of stress at temperatures greater than 170°K. (tr-SJR)

**20334** (NRL-Report-7844) CYCLIC-CRACK-GROWTH AND FRACTURE RESISTANCE OF Ti–6Al–6V–2Sn AS INFLUENCED BY RECRYSTALLIZATION ANNEAL AND INTERSTITIAL OXYGEN CONTENT. Kondas, K. R.; Crooker, T. W.; Gilmore, C. M. (Naval Research Lab., Washington, D. C. (USA)). 8 Jan 1975. 16p.

This study was undertaken to determine methods for metallurgical improvement of cyclic-crack-growth and fracture properties in Ti–6Al–6V–2Sn. Two heats of the alloy were studied: an $\alpha + \beta$-processed material containing 0.16% interstitial oxygen and a $\beta$-processed material containing 0.08% interstitial oxygen. All test specimens were given a mill anneal heat treatment; in addition some specimens from each heat were given a recrystallization anneal heat treatment. Fatigue-crack growth rates were determined using compact tension specimens, and fracture toughness was determined using 1-in. dynamic tear specimens for each combination of material and heat treatments. The recrystallization anneal treatment resulted in significant improvements in the fracture resistance of both materials, despite metallographic evidence that the recrystallization-annealed $\beta$-processed material did not develop a fully recrystallized structure. Improvements in cyclic-crack-growth resistance resulting from the recrystallization anneal treatment, per se, were modest for both the $\alpha + \beta$-processed and $\beta$-processed materials. However, the combined effects of recrystallization anneal plus a reduction in interstitial oxygen content significantly improved the cyclic-crack-growth properties of Ti–6Al–6V–2Sn. (11 figures) (auth)

**20335** (ORO–3105-43) PROGRESS REPORT, MAY 1, 1974–APRIL 30, 1975. (Virginia Univ., Charlottesville (USA)). 1975. Contract AT(40-1)-3105. 18p. Dep. NTIS $4.00.

Research results are reported on high field magneto resistance in Fe, Shubikov de Hass oscillations in Fe, superconductivity in dichalcogenides, inelastic tunneling spectroscopy applications, and transport properties of dilute alloys. (JRD)

**20336** (ORO-4044-5) TECHNICAL PROGRESS REPORT ON STUDIES OF MICROSTRUCTURE-PROPERTY RELATIONSHIPS IN AUSTENITIC STAINLESS STEEL. January 1, 1974–December 31, 1974. Spruiell, J. E. (Tennessee Univ., Knoxville (USA). Dept. of Chemical and Metallurgical Engineering). [nd]. Contract AT(40-1)-4044. 9p. Dep. NTIS $4.00.

The research program studies: thermal and mechanical processes for varying the microstructures, the effects of such processes on microstructural stability during high-temperature aging, and the properties resulting from these treatments and aging. A summary is given of the study of post-weld treatments on the high-temperature phase instabilities in Type 316 and 16 Cr–8 Ni–2 Mo weldments. (DLC)

**20337** (RD/B/N-3097) FATIGUE CRACK PROPAGATION DUE TO RANDOM AMPLITUDE VIBRATIONS: THE INFLUENCE OF STRESS INTENSITY MEAN ON PROPAGATION RATE. Priddle, E. K. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Sep 1974. 18p. Dep. NTIS (US Sales Only) $4.00.

A room-temperature investigation concerning the growth of fatigue cracks in EN3A mild steel subjected to random amplitude loadings is described. Conventional fracture mechanics parameters are used to describe and predict the process of crack propagation under various mean loading conditions. Previously reported constant amplitude data are used in conjunction with program RAFCP to calculate the experimental results. Fracture surfaces of specimens were examined and compared with surfaces produced during constant amplitude propagation. (auth)

**20338** (RLO-2225-T13-23) STUDY OF PHASE TRANSFORMATIONS AND SUPERCONDUCTIVITY. Annual Progress Report. Begej, S.; Jones, W.; Prince, F.; Taggart, R.; Polonis, D. H. (Washington Univ., Seattle (USA). Coll. of Engineering). 15 Oct 1974. Contract AT(45-1)-2225-T13. 67p. Dep. NTIS $6.50.

Emphasis is on control of microstructure and constitution as a means of improving the physical properties of alloys. An example is found in the magnetization studies of the superconducting Zr–Nb alloys at 4.2°K: Measurement of both $T_c$ and the magnetic characteristics were found valuable for monitoring the phase transformations in this system. Details of the transformation processes were investigated as a basis for improving the superconducting characteristics of beta-stabilized alloys. Electron microscopy techniques, electrical resistivity, and x-ray analysis were used to study structural modifications resulting from the thermal treatment of Zr–Nb alloys. A combination of deformation, aging, and reversion heat treatments was investigated as a basis for improving the strength and ductility of the beta-stabilized alloy Ti–11.5 Mo–6Zr–4.5Sn. Suitable control over the volume fraction of the omega phase in this alloy results in enhanced yield strength combined with some ductility. Deformation of the metastable beta phase in the quenched alloy promotes bi-modal precipitation of the alpha and omega phases. The stability of the fine alpha particles maintains high strength with improved ductility after the omega phase has reverted. Superconductivity studies involving Zr–Nb binary alloys are nearing completion. The origin of the flux instabilities in beta-stabilized alloys containing the omega phase was reassessed. The "peak effect" and flux jump phenomenon are due to the omega phase. The size and distribution of the omega phase and the constitution of the alloy act together so that under an applied external magnetic field the omega particles may exhibit either superconducting or normal behavior. When the particle size of the omega phase is comparable to the coherence length of the alloy, a "peak effect" is evident. As the omega particle size increases and the solute enriched zones around the particles impinge, the conversion of the omega particles to the normal state results in an avalanche of flux that momentarily turns the bulk material normal, thereby producing a flux jump. Elimination of the omega phase by a reversion treatment will remove either the "peak effect" or the flux jump. When the alloy is re-aged after reversion, the omega phase will reprecipitate, but under these conditions the alloys exhibit stable magnetic behavior, indicating that the superconducting magnetic stability can be enhanced by treatments to control the decomposition of the beta phase. Tensile strength and ductility are also improved so that the material can be made into wire or sheet. When plastic deformation is introduced prior to the precipitation of the omega phase in a beta-stabilized alloy, the critical field $H_{c_2}$ is doubled. An empirical equation was developed for the calculation of the critical current density $J_c$. An investigation of the precipitation processes in Hf–Nb alloys was initiated. Results to date do not indicate that the omega phase precipitates in a Hf–35 at.% Nb alloy, only that some form of alpha precipitation predominates during aging at 400°C; further work is necessary. In an initial study of the superconducting characteristics of dispersion-type alloys in a nonsuperconducting matrix, it was possible to define the criteria that must be met if such alloys are to be successful superconductors. It has not been possible to meet all these conditions so that only limited superconducting effects have been possible. Consideration was also given to the Nb–Al system; it was possible to produce the superconducting state in Nb–10 at.% Al and 15 at.% Al alloys. A transition temperature value of 17°K was obtained in the case of the Nb–10 at.% Al, and superconductivity was attributed to the coarse interconnected precipitates of $Nb_3Al$. (17 figures, 54 references) (DLC)

**20339** (RN-S-0548) MULTIPLE REGRESSION ANALYSIS OF CONSOLIDATED RADIATION EFFECTS DATA, NERVA MATERIALS, TENSILE PROPERTIES OF INCONEL 718 (PARENT METAL). Springer, H. L.; Lev, M. S. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1970. 185p. Dep. NTIS $12.25.

Radiation effects data on Inconel 718 drawn from a computerized storage are reported and analyzed. The numerical results of the program are presented in tables and charts. (JRD)

**20340** (RN-TM-0157) PRESSURE VESSEL MATERIALS INVESTIGATION AND RESEARCH. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 30 Jun 1965. 68p. Dep. NTIS $6.50.

A compilation of tensile data on NRX pressure vessel materials is presented. Results of tensile tests on Al-base alloys, alloy A-286, inconel 718, and Ni maraging steels at –423 to 600°F are included. (auth)

**20341** (TID–26135) FATIGUE, TENSILE, AND RELAXATION BEHAVIOR OF STAINLESS STEELS. Conway, J. B.; Stentz, R. H.; Berling, J. T. (Mar-Test, Inc., Cincinnati, Ohio (USA)). 1975. 276p. Dep. NTIS $7.60.

Data and information are presented on short-term tensile, relaxation, and low-cycle fatigue behavior of stainless steels. Chapters are included on low-cycle-fatigue test procedures, low-cycle fatigue data, cumulative-damage concepts, short-term tensile data, and relaxation behavior. (JRD)

**20342** (TID/SNA-2) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Supplement 1. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1971. 58p. Dep. NTIS $6.00.

Data on properties of alloy Ti–5Al–2.5 Sn ELI, alloy A-286, and graphite composite AG Carb-101 are presented. (JRD)

**20343** (TID/SNA–3) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Supplement II. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Oct 1971. 43p. Dep. NTIS $5.25.

Data are presented on properties of alloy 718, AISI 440C, alloy 22-13-5, Phosphor bronze, and AISI 9310. (JRD)

**20344** (TID/SNA-106) NERVA LINES-ALUMINUM WELDS TEST REPORT. Fletcher, C. W. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Oct 1970. 36p. Dep. NTIS $5.00.

The weld tensile properties of the seven aluminum alloys evaluated during the aluminum weldability program are presented. The aluminum alloys and the weld filler-wire combinations that were investigated are listed. The manual tungsten-inert-gas (TIG) weld process was used for all weldments. The properties

of dc straight-polarity (SP) and ac current welds, and of weld-bead-reinforcement "on" versus weld-bead-reinforcement "off" are compared. The effect of weld defects on weld properties at room and cryogenic temperatures is recorded, and shown photographically in x-ray films of the welds and the fracture face of the tensile specimens. An evaluation of the weldability and crack sensitivity of the various alloys is presented. (auth)

**20345** (TID/SNA-110) MANUAL OF MATERIALS DATA RELEASE MEMORANDA. Supplement III. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1972. 57p. Dep. NTIS $6.00.

Specifications for NERVA reactor materials are presented. Included are data on Alloy 22-13-5, Alloy A-286, Ti-5Al-2.5Sn ELI alloy, AISI 440C, and Al alloy 6061. (JRD)

**20346** (UCLA-34P177-22) REACTOR STEELS STUDIES. Quarterly Progress Report, January-June 1974. Ono, K.; Ardell, A. J.; Tetelman, A. S. (California Univ., Los Angeles (USA). Dept. of Materials). Oct 1974. Contract AT(04-3)-34. 10p. Dep. NTIS $4.00.

Activities on studies of the mechanical properties of Cr-Mo steels and stainless steels. Portions are abstracts of ORNL-4963 (pp 261-282) and ORNL-4998 (pp 329-364). (DLC)

**20347** (UCRL-51682(Pt.2)) BEHAVIOR OF POROUS BERYLLIUM UNDER THERMOMECHANICAL LOADING: PART 2. Quasi-static Deformation. Schock, R. N.; Abey, A. E.; Duba, A. G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Oct 1974. Contract W-7405-eng-48. 20p. Dep. NTIS $4.00.

Results of loading and unloading of two types of porous beryllium under conditions of uniaxial strain and hydrostatic pressure indicate that the total volume change before the onset of yielding is small and that there is a maximum stress-porosity function which describes pore-collapse, independent of loading and unloading cycles. Comparison of the data taken prior to yielding with theoretical models shows the influence of aspherical pores which result in increased compressibility on initial loading. Initial yielding is much more distinct in the sintered than in the unsintered material and is believed to be an indication of the presence of pores of higher average sphericity produced by the sintering process. Both materials exhibit shear-enhanced compaction when loaded in uniaxial strain. (auth)

**20348** CONCENTRATION DISTRIBUTION IN THE LIQUID INTERLAYER DURING CONTACT FUSION OF BINARY METALLIC SYSTEMS. Temukuev, I. M.; Getazheev, K. A.; Akhubekov, A. A.; Savintsev, P. A. Uch. Zap., Kabardino-Balkar. Gos. Univ.; No. 39, 82-85(1972). (In Russian).

The thermo-emf method was used to show the concentration distribution in the contacting layer between Bi and Sn at 190°C and between Cd and Sn at 185, 190, and 200°C. For all temperatures the ratio of $D_A/D_B \approx 3$ ($D_A$ and $D_B$ are the respective partial diffusion coefficients of the two components). For the Cd-Sn system the temperature dependence of $D_A$ and $D_B$ is exponential. The pre-exponential factors $D_0$ are ~0.16 and 0.05 $cm^2/s$ for Cd and Sn, respectively. (Referativnyi Zh.)

**20349** EFFECTS OF SURFACE TREATMENT ON TYPICAL ELECTROCHEMICAL PROPERTIES OF AN INDIUM MICROELECTRODE. Piercy, R.; Hampson, N. A. (Loughborough Univ. of Tech., Eng.). Electrodeposition Surface Treat.; 2: No. 6, 501-504(Nov 1974).

The surface treatment of In to produce smooth microelectrode surfaces suitable for making accurate electrochemical measurements is described. It is shown that the reproducibility of differential capacitance measurements on solid indium can be greatly affected by the surface pretreatment of the electrode. Problems arise on account of the softness of the metal and also because of the difficulty in electropolishing an indium microelectrode. A simple polish and chemical etch procedure was found to give very satisfactory reproducibility of experimental results. (auth)

**20350** BAND STRUCTURE OF FERMI SURFACE OF $In_3Sn$ ALLOYS IN THE $\beta$-PHASE. Maciejewski, S. (Univ., Poznan, Poland). Phys. Status Solidi (b); 66: No. 2, 633-638(1 Dec 1974).

Band structure calculations are performed for $In_3Sn$ alloys with Sn concentrations from 16.2 to 30 at. % by the pseudopotential method with the Animalu-Heine model potential. From the dispersion relations E(k) obtained, the Fermi surface parameters of the alloys are determined. In the point R of the Brillouin zone, the influence of spin-orbit interaction is calculated. (auth)

**20351** DIFFERENTIAL METHOD OF DETERMINING SHEAR STRESSES IN HOT-TORSION TESTS. Shvartsbart, Ya. S.; Stepanov, V. P. Ind. Lab. (USSR) (Engl. Transl.); 40: No. 6, 901-904(Jun 1974).

Translated from Zavod. Lab.; 40: No. 6, 733-735(Jun 1974).

A method is proposed for determining shear stresses in torsion tests based on a comparison between the torques measured in the same material under identical temperature and velocity conditions but using samples with different diameters of the working part. The assumptions on which the method is based are outlined. Tests to validate the method were carried out on the steel containing Ni, Mo, and Cu. The results obtained were equivalent to the results of the plastometric test. (JSR)

**20352** RESISTIVITY OF SOLID Fe, Cu, W, Nb, Ta, Mo, AND Pd USING T MATRIX. Khanna, S. N.; Jain, A. (Univ. of Delhi). J. Phys., F (London); 4: No. 11, 1982-1986(Nov 1974).

Calculations are presented of the electrical resistivity of solid Fe, Cu, W, Nb, Ta, Mo, and Pd using the t matrix formulation of Ziman's nearly free electron formulas. The calculated values are in good agreement with experimental values. (auth)

**20353** MORPHOLOGY OF PLANAR VACANCY AGGREGATES IN COPPER. Savino, E. J.; Perrin, R. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Phys., F (London); 4: No. 11, 1889-1897(Nov 1974).

The morphology of small planar aggregates of vacancies in copper has been investigated by computer simulation. Clusters of as few as six vacancies have been found to collapse to form loops or stacking fault tetrahedra. This is consistent with the theory that vacancy loops are nucleated directly in individual neutron cascades. Larger triangular clusters collapse and dissociate to form stacking fault tetrahedra by the Silcox-Hirsch mechanism. Hexagonal clusters show a more complex rhombohedral relaxation with extensive dissociation of the Frank dislocation on {111} planes. This may explain the fine structure observed recently in electron microscope images of vacancy loops in copper. (auth)

**20354** TEMPERATURE DEPENDENCE OF THE MECHANICAL PROPERTIES OF RAPIDLY SOLIDIFIED ALUMINUM-1 WT-% ZIRCONIUM ALLOYS. Ohashi, T.; Ichikawa, R. Keikinzoku; 23: No. 3, 113-119(Mar 1973). (In Japanese).

The 0.2% PS and strain-rate sensitivity of precipitation-hardening Al-1% Zr alloys, produced by rapid solidification, were studied in the range 77 to 500°K. At temperatures below ~400°K the deformation mechanism in the as-cast, and the precipitation-hardened alloys, is the same as that of pure Al. Above ~400°K the activation energies of the as-cast and the precipitation-hardened alloys are greater than that for self-diffusion in Al. The activation volumes of the precipitation-hardened alloys remained constant over the whole temperature range. The high-temperature deformation mechanism of these alloys is considered in relation to that in a dispersion-hardened alloy. (Metals Abstr.)

**20355** ALUMINUM-TANTALUM SYSTEM. Kimura, H.; Nakano, O.; Ohkoshi, T. Keikinzoku; 23: No. 3, 106-112(Mar 1973). (In Japanese).

The phase equilibria in the Al-Ta system were studied; two intermediate phases are described. The tetragonal $TaAl_3$ phase, which forms congruently from a melt at 1500 ± 50°C, has a range of solubility at elevated temperature ranging from 22 to 32 at.-% Ta. The $Ta_2Al$ phase (also tetragonal) forms peritectically at 2000 ± 50°C. A eutectic reaction occurs at ~42 at.-% Ta and 1500 ± 50°C between $TaAl_3$ and $Ta_2Al$. The Ta solid solution crystallizes out as a primary phase with a maximum solubility of ~12 at.-% Al at the peritectic temperature of 2000 ± 50°C and decreases markedly with decreasing temperature. (Metals Abstr.)

**20356** STRUCTURE OF $\beta$-TUNGSTEN HEXACHLORIDE BY POWDER NEUTRON AND X-RAY DIFFRACTION. Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Acta Crystallogr., Sect. B; 30: No. 5, 1216-1220(15 May 1974).

$\beta$-$WCl_6$ is isostructural with $UCl_6$ and is hexagonal, space group $P\bar{3}m1$ (No. 164), with a = 10.493 (7) and c = 5.725 (4) Å. The positional parameters of tungsten were determined from the integrated x-ray powder intensities by the profile-fitting technique. One tungsten atom W(1) lies in position 1 (a) (000), and two tungsten atoms W(2) in positions 2(d), $\pm(\frac{1}{3},\frac{2}{3},z)$ with z = 0.473 (6). The chlorine atoms Cl(1), Cl(2) and Cl(3) all lie in positions 6(i) ± (x,$\bar{x}$,z), etc., with x [Cl(1)] = 0.100(1), x [Cl(2)] = 0.440(1), x [Cl(3)] = 0.767 (1), z [Cl(1)] = 0.233 (2), z [Cl(2)] = 0.244(3) and z [Cl(3)] = 0.304(2). The W atoms lie in octahedral holes in the hexagonal close-packed chlorine layers, and the octahedra around W(1) and W(2) are nearly regular. $\alpha$-$WCl_6$, while having similar hexagonal close-packed chlorine layers, has a different arrangement of W atoms in the octahedral holes. (auth)

**20357** NEW TERNARY COMPOUNDS OF EQUIATOMIC COMPOSITION IN THE SYSTEMS OF TWO TRANSITION METALS AND SILICON OR GERMANIUM. Yarmolyuk, Ya. P.; Gladishevs'kii, E. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 11, 1030-1032(Nov 1974). (In Ukrainian).

The existence of 15 new compounds of equiatomic composition was established in the systems of two transition metals and silicon or germanium using x-ray diffraction analysis (single-crystal and powder methods). The compounds {Ti, Zr, Hf, Nb, Ta} ReSi, {Hf, Nb, Ta} MnGe, HfFeGe, and TaMnSi have the crystal structures of the ZrAlNi structure type and Zr {Mo, Mn, Fe} Ge, HfMoGe, and HfWSi-crystal structures of the TiNiSi (E) structure type. (auth)

**20358** THERMODYNAMIC STUDY OF THE Pb–Zn AND Al–In SYSTEMS. Peres, A. E. C.; Campos, V. F. Metalurgia (Sao Paulo); 3: No. 194, 13-18(Jan 1974). (In Portuguese).

An algorithm developed for binary metallic systems having a liquid miscibility gap, based on the equation for change in the molar free energy of mixing proposed by Lumsden, was used to calculate physico-chemical data for the Pb–Zn and Al–In systems. The good agreement of the results with data in the literature is taken as an indication of the general applicability of the algorithm to the type of system studied, some of whose properties are difficult to measure. The results furnished by the algorithm are: the constants of Lumsden's equation, all the lines of the equilibrium diagrams, the critical, eutectic and monoeutectic points, the activities of the metals and the enthalpies and entropies of mixing for the respective systems. (Metals Abstr.)

**20359** HEAT OF FORMATION OF $La_4Bi_3$ AND LaBi COMPOUNDS. Borsese, A.; Capelli, R.; Delfino, S.; Ferro, R. (Univ., Genoa). Theor. Chim. Acta; 9: No. 3, 313-317(Jul 1974).

In the solid-state La–Bi system, formation heats were measured at 300°K using a direct isoperibol calorimeter. The error is ± 0.5 kcal/g-at. The probable existence of a phase having a composition near to $LaBi_2$ was observed. (auth)

**20360** ELEVATED TEMPERATURE PROPERTIES OF AUSTENITIC STAINLESS STEELS. Symposium Held at Miami Beach, Florida, June 24–28, 1974. Schaefer, A. O. (ed.). New York; American Society of Mechanical Engineers (1974). 159p. (CONF-740684-).

Papers are included on creep of 316 stainless steel, stress-strain behavior of 304 stainless steel, creep of 304 stainless steel, yield strength of austenitic stainless steels, effects of cesium oxides on tensile properties of 316 stainless steel, effects of temperature on tensile properties of 304 stainless steel, and fabrication of FFTF piping. (JRD)

**20361** LOCATION OF OPTICAL TRANSITIONS IN $\vec{k}$ SPACE FROM ANGULAR PHOTOEMISSION MEASUREMENTS ON W. Turtle, R.R.; Callcott, T.A. (Department of Physics, University of Tennessee, Knoxville, Tennessee). Phys. Rev. Lett. 34: No. 2, 86-89 (13 Jan 1975).

The energy and emission angle of electrons photoemitted from the (110) and (111) surfaces of W have been measured for photon energies between 7.7 and 10.7 eV. For prominent transitions, the component of internal $\vec{k}$ vector tangential to the surface was obtained from angular measurements on each of the two surfaces. The two components of $\vec{k}$ were used to determine the internal $\vec{k}$ vector of prominent transitions occurring in the plane defined by the ⟨110⟩ and ⟨111⟩ axes. (auth)

**20362** ANGULAR DEPENDENCE OF THE PHOTOELECTRON SPECTRA OF HYDROGEN ADSORBED ON W(100). Egelhoff, W.F.; Perry, D.L. (Department of Physical Chemistry, University of Cambridge, Cambridge, England). Phys. Rev. Lett. 34: No. 2, 93-96 (13 Jan 1975).

The ultraviolet photoelectron spectra of hydrogen adsorbed on W(100) have been studied as a function of the angle of emission. An analysis of this angular dependence at saturation coverage shows some indication of a two-dimensional band structure in the hydrogen-induced energy levels. We discuss the nature of the bands in terms of a molecular-orbital calculation of this adsorbed system. (auth)

**20363** STRUCTURAL ANOMALIES IN CUBIC (A15)$V_3Si$ AND $Nb_3Sn$. Varma, C.M.; Phillips, J.C.; Chui, S. T. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. Lett. 33: No. 20, 1223-1226 (11 Nov 1974).

A variety of anomalous properties of A15 compounds can be explained by assuming that the perfect lattices become unstable at low temperatures, but are stabilized by small distortions around point defects which increase with decreasing temperature. In particular, the presence of vacancies explains discrepancies between sound-velocity measurements and recent lattice-constant measurements as a function of pressure. (auth)

**20364** NEW MOLYBDENUM STAINLESS STEELS FOR CORROSION RESISTANCE: A REVIEW OF RECENT DEVELOPMENTS. Steigerwald, R. F. (Climax Molybdenum Co., Pittsburgh). Mater. Performance; 13: No. 9, 9-16(Sep 1974).

Corrosion resistant alloys containing Mo are examined. Among the topics covered are the low carbon and nitrogen Fe–Cr–Mo ferritic stainless steels, austenitic stainless steels with Mo and N, duplex stainless steels, and cast martensitic steels. The recent progress in developing Ni–Mo and Ni–Cr–Mo alloys with better as-welded corrosion resistance are also outlined. (auth)

**20365** PROPERTIES OF WELDS IN LOW CARBON Mn–Mo–Cb LINE PIPE STEELS. Sawhill, J. J. Jr.; Wada, T. (Climax Molybdenum Co., Ann Arbor, MI). Weld. J. (N. Y.); 54: No. 1, 1s–11s(Jan 1975).

From 55th AWS annual meeting; Houston, TX (6 May 1974).

The properties of welds in commercially produced Mn–Mo–Nb steel were determined by various methods. The results of y-groove restraint cracking tests and modified implant tests indicated that the low-carbon Mn–Mo–Nb steels investigated had a low susceptibility for hydrogen (delayed) cracking. By alloying the weld metal with Ti and/or V, high impact toughness could be obtained at low temperatures in the fusion zone of welds typical of the longitudinal or spiral seam of line pipes. The heat-affected zone toughness as measured by the Charpy impact test was adequate for −10°F service, but was found to vary significantly with the testing conditions. The fatigue strength of welds in Mn–Mo–Nb steel was close to that of the base plate when the reinforcement was removed. (11 tables, 19 fig.) (auth)

**20366** LOW TEMPERATURE INTERNAL FRICTION IN THE NIOBIUM–HYDROGEN AND NIOBIUM–OXYGEN–HYDROGEN SYSTEMS. Mattas, R. F. Urbana, IL; Univ. of Illinois (1974). 92p. University Microfilms Order No. 75-364.

Thesis (Ph. D.).

The motion of hydrogen and the interaction of hydrogen with other defects in Nb were studied using the pulse-echo technique of internal friction at 80 to 350°K and 10 to 310 MHz. Onset of hydride precipitation was observed as a sharp increase in the internal friction at the solvus temperature. In addition, relaxations due to hydrogen–dislocation defects, oxygen–hydrogen defects, and oxygen–deuterium defects were found, and evidence was found for the relaxation of single deuterium atoms. Determination of activation enthalpies of motion, pre-exponential frequency factors, and binding enthalpies were made from the observed relaxations. The hydrogen–dislocation defect was found to have a binding enthalpy in the range from 1.3 to 4.1 kcal/mole. The oxygen-hydrogen defect was shown to have a binding enthalpy of 2.0 ± 0.3 kcal/mole and an enthalpy of motion of 3.6 ± 0.3 kcal/mole. The oxygen–deuterium defect was shown to have a binding enthalpy of 3.0 ± 0.4 kcal/mole and an enthalpy of motion of 4.65 ± 0.4 kcal/mole. The defect tentatively identified with single deuterium atoms was shown to have an enthalpy of motion of 2.85 ± 0.6 kcal/mole. (Diss. Abstr. Int., B)

**20367** STUDY OF PRECIPITATION IN COPPER+13 ATOMIC PERCENT BERYLLIUM BY NUCLEAR MAGNETIC RESONANCE AND FIELD ION MICROSCOPY. Yen, A. C. C. Urbana, IL; Univ. of Illinois (1974). 127p. University Microfilms Order No. 75-474.

Thesis (Ph. D.).

For the $\alpha$ solid solution, the wipe-out-number describing the copper resonance amplitude is found to be 18 for the central transition. Aging data are obtained for Cu–13 at.% Be at 280 and 350°C. The observed aging curves are consistent with published values of the activation energy for diffusion of Be in Cu. An apparent equilibrium composition of the $\alpha$-matrix at various temperatures was evaluated from the NMR absorption intensity in the completely precipitated state. A deviation from the beryllium solvus boundary is observed and found to be a temperature (aging) dependent quantity. A field ion microscope was constructed; various conditions of image gas composition and pressure were tried for imaging pure copper and Cu–13 at.% Be. Both pure copper and the alloy were successfully imaged. The precipitate in Cu–13 at.% Be formed at 280°C is observed and its size is found to be in the order of $2 \times 10^4 Å^3$. A thin layer of copper atoms around each precipitate particle is excluded from the observed NMR absorption intensity because of local lattice and electronic effects. Small precipitate particles, such as those observed with the field ion microscope, embedded in the $\alpha$-matrix cause a shift in the equilibrium beryllium concentration in the $\alpha$-phase. Results with the Thomson–Freundlich equation are used to estimate the interface energy. The value obtained, 577 ergs/cm², falls reasonably well within the range of known surface energies. The Knight shift of CuBe is measured for the first time; its value $K_{CuBe} = 0.13\%$ is found to be very close to that of CuZn (same crystal structure), $K_{CuZn} = 0.15\%$ measured by G. W. West. (Diss. Abstr. Int., B)

**20368** ANISOTROPY OF MAGNETIZATION JUMP FIELD IN $SmCo_5$ SINGLE CRYSTALS. Ulyanov, A. I.; Deryagin, A. V.; Kandaurova, G. S. (Ural State Univ., Sverdlovsk, USSR). Phys. Status Solidi (a); 26: No. 2, K167-K170(16 Dec 1974).

Anisotropy was studied in $SmCo_5$ monocrystals in which

magnetization reversal is achieved in a single magnetization jump in a field $H_0$. The angular dependence of $H_0$ and the $H_0$ ($H_m$) ($H_m$ = magnetizing field) dependence can be explained qualitatively as from the formation of nuclei of reversed magnetization at magnetic non-uniformities. (DLC)

**20369** STUDY OF THE GRAIN BOUNDARY DIFFUSION OF IRON IN TUNGSTEN BY MEANS OF AUTORADIOGRAPHIC AND SECONDARY-ION MASS SPECTROMETRIC METHODS. Kozma, L. (Research Inst. for Technical Physics, Budapest); Riedel, M. M.; Bartha, L. Phys. Status Solidi (a); 26: No. 2, 711-720 (16 Dec 1974).

A mathematical model was developed and microautoradiographic and SIMS methods used to measure the diffusion at relatively low temperatures ($T \lesssim 0.6\ T_M$). The grain-boundary diffusion of iron in polycrystalline tungsten was determined at 1200 to 2300°K. The Arrhenius-type relationship was found to be valid for the whole range with the following contants: $D_0 = (0.18 \pm 0.11)$ $cm^2s^{-1}$, $Q = (77.40 \pm 3.70)$ kcal/g atom. (7 fig) (auth)

**20370** MAGNETIC MEASUREMENTS ON $Y(Fe_xCo_{1-x})_2$ IN THE REGION OF LOW Fe CONCENTRATIONS. Steiner, W.; Ortbauer, H. (Technische Hochschule, Vienna). Phys. Status Solidi (a); 26: No. 2, 451-457(16 Dec 1974). (In German).

Magnetic measurements are reported for the pseudobinary mixed-crystal-series $Y(Fe_xCo_{1-x})_2$ ($MgCu_2$-type) at 4.2 to 300°K and in fields up to 70 kG. A very strong decrease of the magnetic moment and the Curie temperature in vicinity of x = 0.167 can be detected. For $x \leqq 0.12$ no magnetic ordering down to 4.2°K was observed. Extrapolating the magnetization values of the Fe-containing samples to x = 0 gives no magnetic moment of the Co atoms in $YCo_2$. The magnetic properties of this compound are very sensitive to mechanical deformation. From a plot of the mean 3d moment versus x it follows that magnetic ordering is observed only when an Fe-Fe exchange interaction between nearest Fe neighbors becomes possible. (9 fig) (auth)

**20371** CURIE TEMPERATURES OF FERROMAGNETIC ALLOYS AND MAGNETIC PROPERTIES OF PARAMAGNETIC ALLOYS IN THE FCC Co-V ALLOY SYSTEM. Aoki, Y.; Yamamoto, M. (Tohoku Univ., Sendai). Phys. Status Solidi (a); 26: No. 2, K137-K139(16 Dec 1974).

$T_C$ of the quenched ferromagnetic alloys containing up to 22.8 at. % V and the magnetic susceptibility of the paramagnetic alloys containing 24.2 to 30.1 at.% V were measured. (DLC)

**20372** LOW TEMPERATURE DOMAIN WALL MECHANICS IN ANNEALED SPECIMEN $Sm_{0.167}Co_{0.833-x}Al_x$. Oesterreicher, H. (Univ. of California, San Diego, La Jolla). Phys. Status Solidi (a); 26: No. 2, K117-K121(16 Dec 1974).

Alloys with x = 0.10, 0.15, and 0.20 were prepared and given various heat treatments. Annealing was found to produce magnetic hardness at higher x values. Kinks were observed in the magnetization-demagnetization curves. The slope of demagnetization is increased when the specimens were prepared with a subsequent annealing rather than only quenching from the melt, indicating homogeneous pinning. The annealing has produced a change to a uniform energy barrier. (DLC)

**20373** FORMATION OF LOCALIZED MOMENTS IN METALS: EXPERIMENTAL BULK PROPERTIES. Rizzuto, C. (CNR, Genoa). Rep. Progr. Phys.; 37: 147-229(1974).

Experimental data are presented on bulk properties of alloys and intermetallic compounds containing atoms of transition metals, rare earths, or actinides which can be considered as non-interacting with each other. Criteria for the observation of effects due to non-interacting atoms are given. Data are reported from measurements of magnetic properties, electrical resistivity, specific heat, superconductivity, thermoelectric power, thermal conductivity, thermal expansion, and compressibility, De Haas-van Alphen and Hall effects and optical properties. Systematic trends in experimental behavior can be observed in many of these data, and using this observation experimental parameters are defined which are used to classify the data before attempting a comparison with theories. (auth)

**20374** STRUCTURE TRANSFORMATIONS IN THE CREEP RESISTANT NICKEL ALLOY E1765 ARISING FROM THE HEAT TREATMENT AND THEIR CONNECTION WITH THE MECHANICAL PROPERTIES. Filatova, M. A. Tr., Tsent. Nauch.-Issled. Inst. Tekhnol. Mashinostr.; No. 107, 78-82(1972). (In Russian).

Recommended heat treatments were applied to the Ni-base alloy E1765 [Fe 3, 0 maximum, Al 1.7 to 2.3, Cr 13 to 16, C 0.1 to 0.16, Mo 3 to 5, W 4 to 6, and B 0.01%] and studies then made of structural changes and the short- and long-term mechanical properties. Components made from this alloy cannot be used without heat treatment and consideration is given to such practical problems as the reason why certain components do not heat satisfactorily. (Referativnyi Zh.)

**20375** EFFECT OF BORON CONTENT ON CARBON STEEL WELDS. Devletian, J. H. (Youngstown State Univ., OH); Heine, R. W. Weld. J. (N.Y.); 54: No. 2, 45s-53s(Feb 1975).

From 55th annual meeting of the American Welding Society; Houston, TX (6 May 1974).

An analysis is presented of boron's effect on the hardenability, microstructure, and notched tensile strength of carbon steel welds which were deposited by the GTA and GMA welding processes. Single pass welds were deposited on ¼ in. thick 1020 and 10B20 steel plates using filler metal of varying boron contents. Boron was found to significantly affect the microstructure of steel weld metal by effectively retarding the pearlite reaction during weld cooling in favor of the transformation to a bainitic carbide-ferrite aggregate (granular bainite). Furthermore, the amount of $Fe_{23}(B, C)_6$ borocarbide precipitation forming at prior austenite grain boundaries and solidification cell boundaries was found to increase with increasing boron content and decreasing weld cooling rate. Boron's hardenability effect was found to be just as potent in weld metal as it was in wrought steel of the same composition. The hardenability of as-deposited welds was measured by comparing the weld cooling rate and hardness with similar cooling rates and hardness data from Jominy end quenched bars of the same steel. Although the notched tensile strength of boron steel welds was superior to boron-free steel welds, boron's strengthening effect was greatly dependent upon the amount of boron present in the weld. In fact, maximum notched tensile strength was attained in 0.2% C steel weld metal with an optimum boron content of 0.002%. The reduction of notched strength at excessive boron concentrations was due to the presence of embrittling intergranular and intercellular borocarbides. Furthermore, in GTA, GMA, and submerged arc welds notched tensile strength varied directly as a function of the soluble boron content rather than the total boron content. Because of the faster weld cooling, GTA and GMA welds were significantly stronger than the slower cooling submerged arc welds. (auth)

**20376** BAND STRUCTURE SPECTROSCOPY OF METALS AND ALLOYS. Conference Held at Strathclyde, England, September 26-30, 1971. Fabian, D. J.; Watson, L. M. (eds.). London; Academic Press Inc. (1973). 768p. (CONF-710993-). pounds 11.80.

Approximately 39 papers were presented at the conference. A separate abstract was prepared for each of four papers selected by NSA scope. Papers for which no abstracts were prepared are concerned with theory and many-body effects of soft x-ray, photoelectron emission from metals and disordered alloys, x-ray absorption, isochromat spectroscopy of alloys, and density of unoccupied electron states. (JRD)

*For abstracts of individual papers see: 20220, and 20377-20379.*

**20377** X-RAY PHOTOELECTRON SPECTROSCOPY IN THE STUDY OF THE BAND STRUCTURE OF METALS. Hagstroem, S. B. M. (Linkoeping Univ., Sweden). pp 73-89 of Band Structure Spectroscopy of Metals and Alloys. Fabian, D. J. (ed.). London; Academic Press Inc. (1973).

From proceedings of the international meeting on electronic structure of metals and alloys studied by the methods of band structure spectroscopy; Strathclyde, UK (26 Sep 1971). See CONF-710993-.

Information on energy-band structure of metals and other solids obtained by x-ray photoelectron spectroscopy (XPS) is reviewed. Principles of XPS investigations are also reviewed along with results of XPS studies of rare earths and applications of XPS. (JRD)

**20378** X-RAY SPECTRA AND ENERGY BAND STRUCTURE OF BINARY ALLOYS OF VANADIUM WITH THE ELEMENTS AT THE END OF THE TRANSITION SERIES. Nemnonov, S. A. (Inst. of Metal Physics, Sverdlovsk, USSR); Kurmaev, E. Z.; Ishmukhametov, B. Kh.; Belash, V. P.; Fomichev, V. A.; Rudnev, A. V. pp 237-250 of Band Structure Spectroscopy of Metals and Alloys. Fabian, D. J. (ed.). London; Academic Press Inc. (1973).

From proceedings of the international meeting on electronic structure of metals and alloys studied by the methods of band structure spectroscopy; Strathclyde, UK (26 Sep 1971). See CONF-710993-.

Results are presented from studies of the energy-band structure of binary V alloys with transition metals at the end of the first transition series. Information obtained by x-ray spectroscopy on the distribution of electron states having various types of symmetry is included. (JRD)

**20379** SOFT X-RAY SPECTRA OF VANADIUM, NIOBIUM, AND THE ALLOYS $V_3Sn$ AND $Nb_3Sn$. Hague, C. F.; Bonnelle, C.

(Univ., Paris). pp 251-257 of Band Structure Spectroscopy of Metals and Alloys. Fabian, D. J. (ed.). London; Academic Press Inc. (1973).

From proceedings of the international meeting on electronic structure of metals and alloys studied by the methods of band structure spectroscopy; Strathclyde, UK (26 Sep 1971). See CONF-710993-.

Results of studies of electron distributions in the d bands of V, Nb, $Nb_3Sn$, and $V_3Sn$ are presented. The results, presented in graphs, show that the changes in the density of states from the metals to the intermetallic compounds are small. Results also show the important part played by oxidation when the spectra of intermetallic compounds are obtained by electron bombardment. (JRD)

**20380** FIELD EMISSION INVESTIGATION OF ADSORPTION AND NUCLEATION OF SILVER ON TUNGSTEN, AND OF THE INTERACTION OF THE DEPOSITS WITH OXYGEN. Wuestner, W.; Menzel, D. (Technische Univ. Muenchen, Garching, Ger.). Thin Solid Films; 24: No. 2, 211-228(Dec 1974).

The adsorption of silver on tungsten field emission tips, the formation of silver layers and crystallites, and the interaction of silver layers and crystallites with oxygen have been investigated using a field emission microscope. Good agreement with earlier work has been obtained for the nucleation of silver crystallites. Smooth silver layers, many monolayers thick, which retain the symmetry of the W tip, can be produced by slow evaporation at 450°K under extreme UHV. Changes in the work function upon adsorption of silver on tungsten agree with those found by others, except that careful calibration of the Ag source leads to a coverage of $6 \times 10^{14}$ $cm^{-2}$ at the work function minimum, in contradiction to Jones. Work function and pre-exponential factor changes suggest the formation of a non-metallic layer at low coverages, which reverts to a metallic layer at higher coverages. The interaction of oxygen with silver layers and with silver crystallites on W tips leads to a work function rise of about 0.5 eV, with an initial sticking coefficient of up to $10^{-2}$ at 90°K. Exposures above 100 L cause strong rearrangement and transport of silver, even at 90°K. Even under these conditions, however, oxygen does not penetrate through smooth silver layers and attach itself to the tungsten surface. It is concluded that oxygen adsorption on silver at low pressures leads to rearrangement of the surface but not to penetration into the bulk. (auth)

**20381** FERROMAGNETIC RESONANCE ABSORPTION FOR THIN ELECTROLYTIC LAYERS OF Ni-Fe-Mo WITH BIAXIAL ANISOTROPY. Grimberg, R.; Cuciureanu, C. (Centre de Recherches Techniques et Physiques, Iasi). Thin Solid Films; 24: No. 2, 197-202(Dec 1974). (In French).

Magnetic absorption resonance was studied in electrodeposited thin films of permalloy (80% Ni) and permalloy with Mo (5% Mo) having biaxial anisotropy achieved by ferromagnetic coupling. The film thickness was 5300 Å. The anisotropy field has values which decrease from 9.6 to 9 Oe for films without Mo and from 5.8 to 3.1 Oe for films with 5% Mo when the working frequency increases from 3 to 9 MHz. The angle between the axes is 20° in both cases. The effective damping parameter corresponding to the precession of the magnetic moment around an equilibrium direction of the constant field perpendicular to the anisotropy axis, decreases with the increase of rf field from 3 to 9 MHz as follows: from 0.35 to 0.10 for the films without Mo and from 0.65 to 0.32 for the films with Mo, the angle between the axes being of 20° in both cases. For the precession of the magnetic moment around a direction perpendicular to the second axis, the effective damping parameter decreases from 0.27 to 0.10 for films without Mo and from 0.66 to 0.28 for films with Mo for the same angles between axes and over the above frequency range. (auth)

**20382** NERNST-ETTINGHAUSEN EFFECT IN IRON-NICKEL ALLOYS WITH ADMIXTURES OF MOLYBDENUM AND SILICON. Vasil'eva, R. P.; Mukimov, K. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 50-52(1974). (In Russian).

A study was carried out of the anomalous Nernst-Ettinghausen constant $Q_s$ and the specific electrical resistance $\rho$ of iron-nickel alloys containing admixtures of molybdenum and silicon as a function of temperature. (SJR)

**20383** INTERMETALLIC COMPOUND PRECIPITATION FROM SOLID SOLUTION IN SOME Ni-Ta AND Ni-Ta-Cr ALLOYS. Aballe, M.; Ramaswamy, V.; West, D. R. F. (Imperial Coll. of Science and Tech., London). J. Less-Common Metals; 39: No. 2, 287-292(Feb 1975).

The aging of a supersaturated solid solution in a Ni-25 wt.% Ta-10 wt.% Cr alloy gives a marked hardening response associated with copious matrix precipitation of bc tetrogonal $Ni_3Ta$ phase; this is in contrast with the lack of hardening and very small precipitation effect occurring in a Ni-25 wt.% Ta alloy similarly aged. It is proposed that the effect of chromium may be mainly attributable to a reduction in the matrix/precipitate lattice mismatch. (auth)

**20384** THERMODYNAMIC INVESTIGATIONS IN THE THORIUM-RHODIUM SYSTEM. Murabayashi, M.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Less-Common Metals; 39: No. 2, 235-246(Feb 1975). (In German).

The Gibbs free energies of formation of the seven intermetallic phases $ThRh_5$, $ThRh_3$, $ThRh_2$, $Th_3Rh_4$, $Th_3Rh_4$, ThRh, and $Th_7Rh_3$ existing in the thorium-rhodium system have been determined by electromotive force measurements using solid galvanic cells with a $CaF_2$ electrolyte: i.e. Th, $ThF_4$ | $CaF_2$ | $ThF_4$, $Th_mRh_n$, $Th_pRh_q$. Data obtained from measurements between 990 and 1170°K are listed. The enthalpy of formation obtained from these data has been correlated with the calculated values based on different thermodynamic models. It is shown that a relation exists between the enthalpy of formation and the lattice contraction of $AuCu_3$- and $TiNi_3$-type transition-metal phases. (auth)

**20385** SOME PHASES IN TERNARY ALLOYS OF TITANIUM, ZIRCONIUM, AND HAFNIUM, WITH MgAgAs or $AlCu_2Mn$ TYPE STRUCTURE. Marazza, R.; Ferro, R.; Rambaldi, G. (Univ., Genoa). J. Less-Common Metals; 39: No. 2, 341-345(Feb 1975).

The following phases have been studied: Ti(Hf)$AlAu_2$, Ti(Zr,Hf)$InAu_2$, Ti(Zr,Hf)$InPt_2$, $TiSbNi_2$, $VAlNi_2$. These are of the $AlCu_2Mn$ (or CsCl) type. In addition, the MgAgAs-type phases, Zr(Hf)SbCo, HfSnPd, and Ti(Zr,Hf)-SnPt, have been prepared. The molar volumes and volume contraction of these compounds are briefly discussed. (auth)

**20386** RELATION BETWEEN THE TRANSITION TEMPERATURE AND THE CRITICAL CURRENT DENSITY OF SUPERCONDUCTING WIRES BASED ON INTERMETALLIC PHASES OF THE $\beta$-W TYPE. Rassmann, G.; Muller, P. (Zentralinstitut fuer Festkorperphysik und Werkstofforschung, Dresden). J. Less-Common Metals; 39: No. 2, 335-339(Feb 1975). (In German).

The effect of structure and structure defects on $T_c$ and $j_c$ was theoretically considered. The relation between $T_c$ and $j_c$ was experimentally tested on powder-metallurgy prepared compacts of $Nb_3Sn$, $Nb_3Al$, and $Nb_3(Al, Ge)$. The results obtained in the measurement of the critical current in a field of 40 kA/cm and a measurement temperature of 4.2°K as a function of $T_c$ ($T_c = T_o - T_c$) were graphed and compared with results obtained by other investigators. (JSR)

**20387** COMPARISON OF PALLADIUM-SILVER AND PALLADIUM-YTTRIUM ALLOYS AS HYDROGEN SEPARATION MEMBRANES. Fort, D.; Farr, J. P. G.; Harris, I. R. (Univ. of Birmingham, Eng.). J. Less-Common Metals; 39: No. 2, 293-308(Feb 1975).

Some palladium-yttrium alloy diffusion membranes have been developed which are both significantly stronger and more permeable to hydrogen than the present, commercially used, Pd-Ag membrane. The permeabilities of these alloys as a function of both temperature and pressure are compared with that of the commercial Pd-25% Ag alloy. The effect of surface oxidation on the activity of the membranes has also been investigated. (auth)

**20388** HIGH PRESSURE POLYMORPH AND COMPRESSION. Liu, L. G. (Univ. of Rochester, NY). J. Phys. Chem. Solids; 36: No. 1, 31-35(Jan 1975).

The effect of pressure on the lattice parameters of the hcp phase of Lu has been studied up to 230 kbar at 23 ± 3°C by means of x-ray diffraction employing a diamond-anvil cell. The data fitted to the Birch equation yield an isothermal bulk modulus of 460 ± 20 kbar with a pressure derivative of 2.8 ± 0.5. The axial ratio (c/a) decreases nonlinearly with increasing pressure, the decrease being 2.4 per cent at 230 kbar. When the pressure exceeds 230 kbar, Lu transforms reversibly from the hcp phase to the Sm-type structure. The transition occurs with increasing pressure in the range of 230 ± 5 kbar. The lattice parameters of the Sm-type structure at about 231 kbar are a = 3.176 ± 0.006 Å and c = 21.77 ± 0.04 Å, and the volume change is -0.21 $cm^3$/mole or -1.6 per cent of the volume of the hcp phase. (auth)

**20389** SILVER-SCANDIUM SYSTEM. Stapf, I.; Kiessler, G.; Gebhardt, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 39: No. 2, 219-225(Feb 1975). (In German).

The constitution of the silver-scandium system has been investigated by thermal analysis and microscopic examination, in order to compliment the results obtained by x-ray diffraction. In this system the intermetallic compounds $Ag_4Sc$ (tetragonal,

$MoNi_4$-type), $Ag_2Sc$ (tetragonal, $MoSi_2$-type) and AgSc (bcc, CsCl-type) were found to exist. The compound $Ag_4Sc$ is formed peritectically at 920°C from $Ag_2Sc$ and the melt; the compounds $Ag_2Sc$ and AgSc have congruent melting-point maxima at 1155 and 1230°C. The complete system is divided into three partial systems. (auth)

**20390** LOW TEMPERATURE DEFORMATION CHARACTERISTICS OF YTTRIUM SINGLE CRYSTALS. Sokaski, M. Corvallis, OR; Oregon State Univ. (1975). 174p. University Microfilms Order No. 74-29,734.

Thesis (Ph. D.).

First order prism slip in yttrium single crystals containing a total interstitial impurity content of about 200 wt ppM is almost entirely stage II deformation with a work hardening rate $\Theta/\mu$ of $2 \times 10^{-3}$. The athermal temperature is about 300°K. Below this temperature an interstitial mechanism is rate controlling for dislocations moving on the first order prism planes. The obstacle energy is 0.31 eV and is substantially independent of temperature. The oxygen impurity does not influence the thermal component of the flow stress, although the athermal component increases with oxygen content. Above 300°K an intersection mechanism controls dislocation movement. Second order pyramidal slip is also almost entirely stage II deformation, but the work hardening rate is $10 \times 10^{-3}$. The critical resolved shear stress for second order pyramidal slip is higher than for first order prism slip. The athermal temperature is approximately 300°K. Fleischer's criteria supporting an interstitial mechanism as rate controlling for dislocations moving on the second order pyramidal planes are satisfied in the entire temperature range that was investigated, i.e., 77 to 297°K. The obstacle energy is 0.54 eV at the athermal temperature. However, the Dorn-Rajnak model supporting a Peierls mechanism is satisfied below 165°K, thus this mechanism could be rate controlling below 165°K. Second order pyramidal slip is active when the tensile axis is less than 37 degrees from the C-axis at 300°K. First order prism slip is active at all other orientations. Basal slip could not be activated at any orientation. (Diss. Abstr. Int., B)

**20391** DECOMPOSITION OF SUPERSATURATED SOLID SOLUTIONS IN NICKEL-RICH NIOBIUM ALLOYS. Quist, W. E. Seattle; Univ. of Washington (1974). 232p. University Microfilms Order No. 74-29,484.

Thesis (Ph. D.).

The decomposition behavior of nickel–niobium alloys containing up to 12.5 at. % niobium was studied by means of electron microscopy, optical microscopy, electron diffraction, x-ray diffraction, and mechanical property techniques. An unreported phase of composition $Ni_8Nb$ was discovered in binary nickel–niobium alloys containing between 8.5 and 11.9 at. % niobium, the $Ni_8Nb$ phase possessing a structure that had not previously been detected. A structural determination was performed by means of electron and x-ray diffraction analysis and was confirmed by electron microscopy and chemical composition. The crystal structure can be described as face-centered tetragonal with a unit cell containing 36 atoms or as an equivalent body-centered tetragonal (the Bravais lattice) unit cell containing 18 atoms. The body-centered tetragonal unit cell is a more basic description because of its conformance to the Bravais lattice designation and its small size but the face-centered cell describes a more straightforward crystallographic relationship to the matrix, and allows the precipitation process to be described most simply. The structure of $Ni_8Nb$ displays an unusual triangular ordering on close packed planes, with niobium atoms being separated by two nickel atoms along the close packed directions. Metastable phases based on the $Ni_3Nb$ composition, denoted $\gamma'$ and $\gamma''$ do not form in binary Ni–Nb alloys. A detailed analysis of ternary and quaternary Ni–Nb base alloys containing iron and/or aluminum has revealed that the presence of these phases is determined by a combination of interfacial strain, crystallographic, and electronic factors. The lattice constants of the matrix and the $\gamma'$ and $\gamma''$ daughter phases must be within ~1.0% of each other for precipitation to occur. Iron additions to Ni–Nb alloys promote the formation of the $DO_{22}$ structured $\gamma''$ phase, in harmony with the prevalent crystallographic characteristics of binary systems where compounds of this type have been reported. Similarly, aluminum additions to Ni–Nb or Ni–Nb–Fe alloys promote the formation of $Ll_2$ structured $\gamma'$ phase, also following the convention of crystallographically similar binary systems. From the viewpoint of Engel-Brewer electronic factors the stability of $DO_{22}$ $\gamma''$ phases is maximized in the range of electron/atom ratios (e/a) of from 2.50 to 2.62. For the $Ll_2$ $\gamma'$ phases the range of e/a ratios where stability is indicated is somewhat higher than for the $\gamma''$ phases, usually near a value of 3.0. These results explain the puzzling problem of why small additions of niobium to complex nickel and iron base alloys can bring about the formation of $Ni_3Nb$ $\gamma'$ and $\gamma''$ phases when these phases do not exist in the Ni–Nb system. $^*B_2$ is the new suggested designation for the previously defined $\beta$ phase. (Diss. Abstr. Int., B)

**20392** GREEN'S FUNCTIONS FOR SOLID STATE PHYSICISTS. Doniach, S.; Sondheimer, E. H. Frontiers in Physics, Number 44. Reading, MA; Addison-Wesley/W. A. Benjamin, Inc. (1974). 282p. $19.00.

Information on Green's function methods for solid state physics is presented in chapters on lattice dynamics in the harmonic approximation, lattice dynamics at finite temperatures, the Feynman–Dyson expansion, scattering of fermions by a localized perturbation, electrons in the presence of many impurities in metals, interacting electron gases, x-ray Kondo problems and superconductivity. (JRD)

**20393** HIGH TEMPERATURE PROPERTIES OF Ti–6Al–2Sn–4Zr–2Mo–0.09Si. Seagle, S. R.; Hall, G. S.; Bomberger, H. B. (RMI Co., Niles, OH). Metals Eng. Quart.; 15: No. 1, 48-54(Feb 1975).

Addition of silicon to about 0.09% results in a significant and nonlinear improvement in elevated-temperature creep strength of the Ti–6Al–2Sn–4Zr–2Mo alloy without any apparent undesirable effects. This addition increases the time for 0.1% permanent deformation (950°F-35ksi) from 15 to 110 h for a fine alpha-beta microstructure. Increasing the silicon from 0.1 to 0.2% appears to decrease the creep strength and impact energy. An excellent combination of properties is realized at about 0.09% silicon. Addition of silicon at less than 0.1% did not affect room temperature tensile properties, thermal stability, workability, or microstructure. In coarse-grained structures of Ti-6242Si, maximum post-creep tensile ductility can be obtained by employing a solution-annealing temperature about 50°F below the beta transus instead of the usual 70°F lower temperature. This increase in temperature reduces the amount of primary alpha to 50% or less, and tends to avoid a network of continuous primary alpha, which is detrimental to thermal stability. Solution annealing at temperatures close to the beta transus broadens the elongated primary alpha grains, and it reduces the alignment as well as the amount of continuous primary alpha. Material with small equiaxed grains of primary alpha in the microstructure has good thermal stability when annealed at temperatures as low as 80°F below the transus. These small equiaxed primary alpha grains are normally surrounded by aged metastable beta products, and are not continuous. Creep resistance is improved significantly as the solution annealing temperature is raised to at least 25°F below the beta transus (highest temperature used in this study). The best creep resistance was obtained with a coarse primary alpha structure relatively free of aligned primary alpha. Solution annealing at temperatures up to 25°F below the beta transus does not affect room temperature tensile properties. (auth)

**20394** UNIAXIAL COMPRESSION OF A FIBER-REINFORCED COMPOSITE. Mileiko, S. T.; Khvostunkov, A. A. (Inst. of Solid State Physics, Moscow). Kovove Mater.; 12: No. 2, 205-214 (1974). (In Russian).

A model for the loss of stability in a fiber-reinforced, metal-matrix composite subject to uniaxial compression is described. Interface stresses and optimal reinforcement conditions are derived for the case where compressive loading is applied in a direction coinciding with the fiber orientation. The validity of the computational model is confirmed by experimental data obtained with Al–Fe and Al–B composites. A two-dimensional model of the composite is elaborated for cases where the composite is compressed at an angle to the fiber direction. (IAA)

**20395** $V_3GA$ GROWTH KINETICS IN VANADIUM/GALLIUM–COPPER COMPOSITES. Critchlow, P. R. (Univ. of Quebec). J. Mater. Sci.; 9: No. 11, 1904-1906(Nov 1974).

$V_3Ga$ is a $\beta$-W type superconducting compound with a high transition temperature, a high upper critical field and capable of carrying a high current density. An important manufacturing process relies on the selective diffusion of gallium into vanadium from a gallium-copper alloy. In the process, a composite of vanadium and gallium-copper is fabricated as a tape or filamentary wire. The composite is mechanically deformed to the desired final size. A heat-treatment in the temperature range 575 to 800°C produces a $V_3Ga$ layer at the interface between the vanadium and the gallium-copper. It is shown that a single equation can reproduce the growth rate of the $V_3Ga$ layer at different reaction temperatures and for different compositions of the gallium-copper alloy. (auth)

**20396** COMPOSITE MATERIALS BASED ON GRANULAR TUNGSTEN CARBIDE AND MANGANESE CUPRONICKEL. Sarkisov, V. S.; Belousov, B. Ya. Svar. Proizv.; No. 9, 23-24(Sep 1975). (In Russian).

The composite materials studied consisted of granular tungsten carbide with granulation 0.18 to 2.2 mm and a plastic binder,

manganese cupronickel containing 60% Cu, 20% Ni, and 20% Mn. A charge consisting of the granular tungsten carbide and the manganese cupronickel powder is pressed into briquettes and sintered in an electric furnace at 1200° C. Among the advantages of this material are the ability to vary mechanical properties by heat treatment and control of the granulation of the tungsten carbide. The material can be used to increase the abrasive wear-resistance of parts. It was experimentally established that the maximum strength of composite materials is achieved by hardening at 580 to 600° C with subsequent aging at 380 to 400° C for 8 to 10 hours. Increasing the grain size of the tungsten carbide decreases the modulus of elasticity of the composite material but increases the impact toughness. Short-term strength increases exponentially with a maximum at 0.63 to 0.9 mm tungsten carbide grain diameter. Maximum wear-resistance is achieved at a grain size of 1.6 to 2.2 mm for sliding friction, 0.18 to 0.28 mm for impact-abrasive wear. (auth)

**20397** STROYENIYE I SVOYSTVA SPLAVOV DLYA ATOMNOY ENERGETIKI. (Structure and Properties of Alloys for Atomic Energy). Ivanov, O. S.; Badaeva, T. A. (eds.). Moscow; Izdatel'stvo Nauka (1973). 192p.

Results of investigations are presented on the structure of equilibrium and metastable phases, the transformation kinetics of solid solutions, the formation and physical chemistry and mechanical properties of alloys based on uranium, thorium, zirconium, and niobium, as a function of composition and temperature. New data are presented on the phase equilibria in binary, ternary, and quaternary systems of uranium with C, Mo, W, Mn, Al, Si, Fe, and other metals, of zirconium with Nb, Sn, O, of niobium with Hf, and Ti, and others; on crystal structures and transformations of metastable phases in binary and ternary systems of uranium with Zr, Mo, Nb, Re, Ru, and others, which were observed during hardening and tempering; on the mechanical and thermoelectric properties of alloys of uranium with Zr, Nb, Mo and Al, and of thorium with Y. On the basis of the systems considered, general principles are presented on structural changes and alloy properties. The collection is intended for researchers, metal scientists, designers, metallurgists, and teachers and students specializing in atomic materials. (JPRS)

**20398** ANISOTROPY OF THE HALL EFFECT IN BERYLLIUM. Gladkov, V. P.; Petrov, V. I.; Protasov, E. A.; Rodionov, A. G.; Skorov, D. M.; Tulupov, I. F. At. Energ. (USSR); 37: No. 6, 463-465(Dec 1974). (In Russian).

Results of measuring the Hall effect in variously oriented single-crystal specimens at 4.2, 77.4 and 293° K in fields from 2 to 15 kOe are presented. The Hall coefficient is negative when the magnetic field is parallel to the hexagonal axis and positive when the magnetic field is perpendicular to this axis. Absolute values of Hall coefficient for beryllium are tens of times higher than for most metals. The signs and orders of magnitude of the coefficients do not change throughout the range of fields and temperatures investigated. The sign and magnitude of the Hall coefficient as given by the two-band model agrees closely with experimental data if one considers that in beryllium anisotropy of the Hall effect is determined by the anisotropy of the effective mass, and the order of magnitude of coefficients by the number of electrons and holes per atom. (auth)

**20399** RF MEASUREMENTS AND IMPURITY EFFECTS IN THE TRANSITION METAL SUPERCONDUCTORS Nb AND Ta. Varmazis, C. D. New York; Columbia Univ. (1974). 146p. University Microfilms Order No. 74-29,674.

Thesis (Ph.D.).

Measurements using rf are described for the superconducting Nb and Ta at 15 MHz using a tunnel diode oscillator. The measurements provide values of $\lambda_L(0)$ for Nb and Ta which are compared with values from literature. The role of impurities on the surface is emphasized and their effect on the penetration depth $\lambda$, through the changes of the boundary condition on the superconducting wave function, is discussed. The variation of the inductive skin depth $\delta_l$ and the resistive skin depth $\delta_r$ close to $T_c$ is described. A peak is observed in $\delta_l$ in the region $\lambda > \delta$. The effect is analyzed in the framework of the London theory for the superconducting state and the normal and anomalous skin effect theories for the normal state. The role of oxygen and its effect on the penetration depth $\lambda$ is also investigated. It is found that besides its effect on the carbon removal and the grain growth the presence of oxygen even in small amounts can cause thermal faceting in Nb during high temperature heat treatment. A discussion is also given on the fluctuations in the surface superconductivity region for Ta. It is found that when a small magnetic field is applied parallel to the surface of a Ta specimen an extremely sharp transition is observed at $H_{c_3}$. The ideal nature of this transition allows an analysis for fluctuations. It is found that the pair conductivity is larger than the value predicted by the theory for the Larkin-Aslamazov term. (Diss. Abstr. Int., B)

**20400** STRUCTURE AND SUPERCONDUCTING PROPERTIES OF BULK AND THIN FILM HARD SUPERCONDUCTORS. Somasundaram, R. Minneapolis; Univ. of Minnesota (1974). 145p. University Microfilms Order No. 74-26,281.

Thesis (Ph.D.).

Superconducting properties of cast and heat treated alloys of niobium with Al, Ge, and Ga were studied as a function of composition and heat fragment. The transition temperature of most beta tungsten alloys increased with heat treatment at 700°C. By heat treatment, it was possible to obtain superconducting transitions beginning above 20°K in a large region in the $Nb_3Al$ side of the quarternary alloys. In some alloys the maximum transition temperature was obtained after three weeks at 700°C while in other alloys it occurred after four weeks. In other alloys, the transition temperature decreased continuously with annealing time. Structure and composition of alloys were studied with x-rays, metallography and electron-microprobe analysis. These studies indicated that the improvement in transition temperature resulted from changes in composition of the A15 phase which occurs during heat treatment. Microprobe analysis of alloys indicated that stoichiometry of the A15 phase is not a necessary requirement for high superconducting transition temperatures. Thin films of some of the A15 Nb alloys were sputtered as a function of applied voltage and substrate temperature from a compound target. In addition, thin films of nitrides and carbides of niobium and tantalum were reactively sputtered. The superconducting characteristics of these films were studied as a function of applied voltage, partial pressure of the reacting gas and substrate temperature. In addition to $T_c$ the structure and composition of the films were determined utilizing x-ray, electron microprobe, and auger analysis. Sputtered films of Nb–Sn with a $T_c$ of 15.6°K and Nb–Ge films with a $T_c$ of 17°K were obtained. Sputtered films of Nb–Al, Nb–Ga and Nb–Al–Ge had poor superconducting properties mainly due to the absence of the A15 phase. While most of the films had crystal structures similar to those observed for bulk materials, a new fcc structure was observed in a Nb–Ge alloy film. The results indicated that the sputtering variables affect the superconducting properties by varying the structure and composition of the film. (Diss. Abstr. Int., B)

**20401** PHASE TRANSITION TIMES IN TYPE I SUPERCONDUCTING TIN FILMS. Neznanski, L. S. Lafayette, IN; Purdue Univ. (1974). 226p. University Microfilms Order No. 74-26,756.

Thesis (Ph. D.).

Measurements have been made of the rise times and delay times which occur during first and second order partial phase transitions from the superconducting to the intermediate state in Type I tin films of varied thickness and width under the influence of a suddenly applied parallel field. The thickness of the tin films is chosen so that the films undergo phase transitions which are uncomplicated by either surface superconductivity or fluxons. The partial first order rise times are compared with the extension of a model accounting for full superconducting-to-normal phase transitions. The full transition model, first published by Brennemann, McNichol, and Seraphim, is based on the hypothesis that the rate of phase transition is controlled by the rate at which latent heat is supplied to the interphase boundaries from the environment. This model is extended to the partial transition regime by assuming that those parts of the film which do not undergo transition will nevertheless cool partly or fully to the interphase boundary temperature and, thus, become a source of latent heat not otherwise available. The test structure is basically a shielded in-line cryotron with the tin gate film vacuum-deposited on an insulated niobium substrate and the control deposited on a separate glass substrate to allow for modification of the tin film width. It is found that the first order rise time is not affected by variations in film width, but that it decreases with decreasing film thickness. These observations are as predicted by both the full and partial transition models. The first order delay time and second order rise time and delay time are unaffected by either variations in film thickness or width. In general, the first order rise time is observed to increase steadily as the applied field decreases. However, an important prediction of the partial transition model, which has been verified experimentally, is that the first order rise time becomes independent of the applied field for values approaching the critical field. This observation is in contrast to the full transition model which predicts continually increasing rise times under the same conditions. In addition, the partial transition model correctly predicts the observed asymptotic approach of the experimental first order risetimes to the equation of the full transition model at applied fields large enough for full, or nearly full, phase transitions to occur. In contrast to first order rise time, the first order delay time increases continually near the critical field. Thus, it appears as if the delay time may also be controlled by thermal effects, but that the film is not as yet cooling sufficiently to supply a significant amount of latent heat. Due to a restricted electron mean free path, the thermal diffusion distance in the tin films is

calculated to be 2 mils or less even at the largest observed rise times of 60 to 200 nsec. Further, the best qualitative predictions of the partial transition model occur for the condition that the films require all of the transition time to cool. Assuming an equally spaced array of normal nucleation sites, the sites are estimated to be approximately 4 mils apart. The second order phase transitions show little of the characteristic first order thermal behavior. This is as expected since no latent heat is absorbed for this case. (Diss. Abstr. Int., B)

**20402** MIGRATION OF SMALL VACANCY CLUSTERS IN MOLYBDENUM. Fastenau, R.; Caspers, L. M.; van Veen, A. (Univ. Delft, Netherlands). Delft Progr. Rep., Ser. A; 1: No. 3, 65-72(Dec 1974).

The migration energy of a vacancy and the configuration change energies of di- and tri-vacancies were calculated for molybdenum using the program RELAX. Calculations show that trivacancy migration may, with reasonable accuracy, be considered as a superposition of the migration of the divacancies involved. The calculated data are inconsistent with the stage-III/stage-IV annealing model for molybdenum proposed by Evans and Petersen; they do not, however, disprove a model proposed by Stals and co-workers. (7 fig.) (auth)

**20403** PHENOMENON OF STEEL SOFTENING AFTER COLD DEFORMATION OF LOW ANNEALED HARDENED STEELS. Survey for Determining the Conditions for Getting the Maximum Effect. De Santis, R. (Istituto di Ricerche Breda, Milan); Matteoli, L.; Chirone, E.; Revello, P. L. Met. Ital.; 66: No. 9, 467-472 (Sep 1974). (In Italian).

The phenomenon of the softening effect by cold deformation of low-annealed hardened steels has been treated by Matteoli and Girotti in 1942 and confirmed by surveys which showed a recovery of hardness after a second annealing. This survey refers to results of tests on 40 NiCrMo 7-ESR steel aiming to determine the annealing conditions for the maximum softening effect by deformation and to show the connection existing between softening and deformation degree. It was ascertained that the maximum softening effect was obtained by annealing temperatures between 350 and 450°C and that it appears not to depend on the deformation degree. (auth)

**20404** PREPARATION OF SUPERCONDUCTING THIN FILMS OF NIOBIUM BY THE METHOD OF THERMOVACUUM DEPOSITION. Alekseevskii, N. E.; Anokhina, I. V.; Ermolov, V. A.; Nikitin, M. M.; Tarasov, G. N. Fiz. Khim. Obrab. Mater.; No. 6, 140-143(1974). (In Russian).

Superconducting thin films of Nb were prepared by evaporation and deposition. The dependences of the critical temperature on the thickness of the film, the temperature of the support, and the vacuum conditions were studied. The structure and properties of the film were studied by x-ray structure analysis and electron microscopy. (tr-auth)

**20405** STRUCTURAL CHANGES IN THE BOUNDARY ZONES OF COMPOSITE MATERIALS OF NICHROME-TUNGSTEN AND FECRAL-TUNGSTEN ALLOYED WITH POWDER ALLOY. Savchuk, A. N.; Ol'shanetskii, V. E. Fiz. Khim. Obrab. Mater.; No. 6, 143-144(1974). (In Russian).

The possibility of alloying the boundary zone of composites of nichrome (fecral)-W with powder alloys introduced between the layers of the matrix and the fibers of the filler was studied. The powders used were Ni-Cr alloys with 0.25% $La_2O_3$, 33% Ni + 33% W + 34% Mo, and 80% Cr + 13% W + 7% Mo. Alloys inhibiting the formation of intermetallic layers in the transition zone were selected. The possibility of controlling the structure and hardness of this zone by means of its tendency to extended microalloying was shown. (tr-auth)

**20406** EFFECT OF THE ELECTRON EXCHANGE OF COMPONENTS IN PROCESSES OF STRUCTURE FORMATION OF MOLYBDENUM ALLOYS. Vinnik, P. G.; Botte, A. V.; Nedyukha, I. M.; Ul'yanov, V. L. Fiz. Khim. Obrab. Mater.; No. 6, 139-140 (1974). (In Russian).

The cast structure of Mo and the character of its change under the effect of additions of Ti, Zr, Co, Fe, Cr, Ni, W, Nb, Hf, Ta, Re, and V were studied during maintenance of the same crystallization conditions for the alloys. An attempt was made to connect the grain size of the alloy with the electron structure of the atoms of the alloying element. (tr-auth)

**20407** TWINNING OF CADMIUM UNDER THE EFFECTS OF ULTRASONIC VIBRATIONS AT 77 AND 300°K. Gindin, I. A.; Neklyudov, I. M.; Volchok, O. I.; Malik, G. N. Fiz. Khim. Obrab. Mater.; No. 6, 136-138(1974). (In Russian).

Data are reported on the metallographic study of the structure of polycrystalline Cd deformed by mechanical alternating vibrations of ultrasonic frequencies at 77 and 300°K. It was observed that during the ultrasonic deformation an intense process of twinning occurs. (tr-auth)

**20408** EFFECT OF TUNGSTEN FILMS ON THE MECHANICAL PROPERTIES OF MOLYBDENUM. Yaroshevich, P. Yu.; Belomyttsev, Yu. S.; Mukhin, I. P. Fiz. Khim. Obrab. Mater.; No. 6, 91-95(1974). (In Russian).

The effect of W films on the mechanism of the plastic deformation of Mo monocrystals was studied. It was shown that the deposition of W films does not change the glide system during deformation. Glide occurred along the {112} ⟨111⟩ and {110} ⟨111⟩ systems. An increase of the strength limit and a decrease of the plasticity of Mo were observed. W films inhibit the process of free release of the dislocation on the surface and because of this the degree of deformation hardening of Mo samples with W films was large in comparison with the degree of hardening of Mo samples with a clean surface. (tr-auth)

**20409** KINETICS OF URANIUM NITRIDE FORMATION IN LIQUID U-Sn ALLOYS. Schicks, T.; Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., CA). High Temp. Sci.; 6: No. 4, 351-368(Dec 1974).

Kinetic studies of UN formation in inductively stirred liquid U-Sn alloys in the 1500-1800°C range by the reaction $U + \frac{1}{2}N_2(g) = UN(s)$, at constant nitrogen pressures have resulted in the formulation of a combined rate model that involves both the diffusion of nitrogen into the stirred liquid alloy and the reversible chemical reaction of dissolved nitrogen with the dissolved uranium. The kinetic rate equation developed from the model is capable of explaining the influence of various parameters affecting the nitride precipitation rate such as melt geometry, stirring, nitrogen pressure, uranium concentration, and temperature. (18 fig, 4 tables) (auth)

**20410** NITROGEN-NITRIDE EQUILIBRIA IN MOLTEN Y-Sn ALLOYS. Fuwa, A.; Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., CA). High Temp. Sci.; 6: No. 4, 259-266(Dec 1974).

The nitride formation reaction in 1.43-10.12% (yttrium) Y-Sn alloys was studied at 1420 to 1510°C by a modified Sieverts technique. The equilibrium data on the YN reaction makes it possible to provide the standard free energy of this reaction for the weight percent activity scale as $Y(\%) + \frac{1}{2}N_2(g) = YN(s)$; $\Delta G^\circ = -25.645 (\pm 370) + 15.67T$. Expressions for the $\Delta G^0_{m,f}$ and $\gamma^0_i$ on the mole fraction activity scale were obtained. The stoichiometry of the nitride formed is shown to be $YN_{1.0}$. (5 fig) (auth)

**20411** PHASE DIAGRAM OF THE URANIUM-RICH PORTION OF THE U-Mn-Fe SYSTEM. Badaeva, T. A.; Kuznetsova, R. I. pp 30-34 of Structure and Properties of Alloys for Nuclear Power Engineering. Section 1. Uranium and Thorium Alloys as the Nuclear Fissile Fuel. Moscow; Izdatel'stvo "Nauka" (1973). (In Russian).

Projections of the liquidus surface in the phase diagram of the uranium corner of the ternary $U-UMn_2-UFe_3$ system were constructed from thermal analysis and measurements of the microstructure. The extent of the regions of primary crystallization of γ-U, β-U, $U_6(Mn,Fe)$, and $U(Mn,Fe)_2$ was determined. The presence of the tetraphase equilibrium $\gamma-U + U_6(Mn,Fe) \rightleftharpoons \text{liquid} + \beta-U$ was established at ~760°C. A three-dimensional representation of the phase diagram was given. (tr-auth)

**20412** MAGNETOELASTIC EFFECTS IN RARE EARTH METALS AND COMPOUNDS. Southern, B. W. Hamilton, Ont.; McMaster Univ. (1973). vp. National Library of Canada, Ottawa.

Thesis (Ph. D.).

A theory developed by Toupin, Tiersten, Brown, and Melcher employing finite strains and angular momentum invariants is applied to ferromagnets which have hexagonal-close-packed or cubic symmetry. A Hamiltonian is written down which includes Heisenberg-exchange, magnetic anisotropy, magnetoelastic terms and the Zeeman term and which is invariant under combined rotations of the magnetic and elastic systems. When the approximations of small-strain theory are subsequently carried out, there appear new terms originating in the magnetic anisotropy that are linear in the antisymmetric strains $\omega_{\mu\nu}$ and correspond to rotations of the elastic medium. The coupling of transverse acoustic waves to the magnetic system is studied and expressions are derived for the dependence of the measured elastic constants on an applied magnetic field in the ferromagnetic phase. Using available data on magnetic anisotropy and magnetostriction, estimates are given for the size of the effects that may be expected to be found in the rare-earth metals (Gd, Tb, Dy, Ho, and Er) and in some of the rare-earth-iron compounds $RFe_2$(R = Tb, Dy, Ho, Er, and Tm). Fractional changes in the elastic constants as large as $10^{-2}$ are predicted in fields of about 50 kOe. Calculations are also performed for the field-dependent changes in $c_{11}$ and $c_{33}$ for longitudinal waves in the paramagnetic region for Dy and Ho. (Diss. Abstr. Int., B)

**20413** THERMAL AND ELECTRICAL CONDUCTIVITIES OF HIGH POROSITY MOLYBDENUM AS A FUNCTION OF TEMPERATURE. Maksimov, A. A.; Vlasov, A. I.; Anishchenko, L. M.; Ligai, L. I. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 52-56(1973). (In Russian).

Determinations were made of the thermal conductivity, $\lambda$, electrical conductivity, $\sigma$, and the Lorenz number of Mo of 60 to 95% porosity in the temperature range 300 to 1300°K. Increasing porosity leads to a fall in $\lambda$ and $\sigma$ with temperature dependence of these properties being the same as for the compact material. Heat transmission in Mo with porosity ≤95% is mainly by electrons. The method for calculating $\lambda$ and $\sigma$ for Mo with porosity >50% is indicated. (Referativnyi Zh.)

**20414** STRUCTURE AND PROPERTIES OF ALLOYS OF MOLYBDENUM WITH CARBON, TITANIUM, AND ZIRCONIUM. Biryukova, T. A.; Mal'tsev, M. V.; Shchukin, A. A.; Parshikov, V. G. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 39-46(1973). (In Russian).

The structure and properties of alloys of Mo with Ti, Zr, and C were studied. Alloys of the Mo–Zr–C system had the best combination of strength and ductility and also the highest recrystallization temperature. (Referativnyi Zh.)

**20415** FRACTOGRAPHIC STUDY OF VACUUM-MELTED TUNGSTEN CONTAINING ADDITIONS OF TANTALUM AND ZIRCONIUM CARBIDE IN THE DEFORMED AND ANNEALED CONDITIONS. Mal'tsev, M. V.; Naumkin, O. P.; Mikhailov, V. G.; Danielyan, T. A. Nauch. Tr., Vses. Nauch.-Issled. Proekt. Inst.; No. 13, 32-38(1973). (In Russian).

Optical and electron microscopy were used in a fractographic study of electron-beam melted W containing Ta 0.2 and ZrC 0.2%, annealed (i) below the temperature of the onset of recrystallization, (ii) at the temperature of recrystallization, and (iii) at the temperature of selective recrystallization. In bend tests, deformed material showed maximum ductility after treatment (i) and the minimum ductility after treatment (ii); treatment (iii) had an intermediate effect. Viscous shear occurred after (i) and a mixed inter- and transcrystalline fracture, with an appreciable fraction of intercrystalline fracture, after (ii). Mixed fracture was also found after (iii) but with an increased proportion of the transcrystalline type leading to an increase in ductility of the metal. (Referativnyi Zh.)

**20416** MODIFICATION OF A RANEY NICKEL CATALYST BY TRANSITION METALS. XIV. Effect of the Thermal History of the Initial Melts on the Activity of the Catalysts. Nalibaev, T. N.; Almashev, B. K.; Fasman, A. B.; Talipov, G. Sh. Russ. J. Phys. Chem. (Engl. Transl.); 48: No. 4, 511-513(Apr 1974).

Translated from Zh. Fiz. Khim.; 48: No. 4, 889-892(Apr 1974).

X-ray diffraction and metallographic analyses have been used to determine the phase composition and the amount of nickel aluminides in the ternary melts $Ni_{50-x}-M_x-50\%$ Al (where M = Cr, Mo, W, Fe) quenched from the liquid state and solution-treated in the range 300 to 900°C. The structure and the specific surface area of catalysts prepared by leaching these alloys have been determined. The catalysts can be divided into two groups according to the effect of heat treatment schedule on the rate of hydrogenation. (auth)

**20417** DETERMINATION OF THE ENTHALPY OF MIXING IN THE Ga–In–Sb AND Bi–Sn–Sb SYSTEMS BY DIFFERENTIAL THERMAL ANALYSIS. Vecher, A. A.; Voronova, E. I.; Mechkovskii, L. A.; Skoropanov, A. S. (Belorussian State Univ., Minsk). Russ. J. Phys. Chem. (Engl. Transl.); 48: No. 4, 584-585(Apr 1974).

Translated from Zh. Fiz. Khim.; 48: No. 4, 1007-1009(Apr 1974).

Enthalpies of mixing have been measured at 910°K by quantitative differential thermal analysis in the ternary gallium–indium–antimony and bismuth–tin–antimony and the binary indium–antimony systems. Ternary solutions show both positive and negative deviations from ideality in the liquid state. (auth)

**20418** INFLUENCE OF SURFACE DEFECTS OF TANTALUM SINGLE CRYSTALS ON THE KINETICS OF CATHODIC HYDROGEN EVOLUTION. Kudryashov, I. V.; Kopalin, N. G. (Inst. of Chemical Tech., Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 48: No. 4, 594-595(Apr 1974).

Translated from Zh. Fiz. Khim.; 48: No. 4, 1023-1024(Apr 1974).

The electrocatalytic activity of tantalum single crystals towards the cathodic evolution of hydrogen in an acid medium after bombardment with various doses of argon ions of 40 keV energy was investigated. The bombardment increases the effective activation energy of the reaction, although the rate of the reaction is not affected, and it tends to nullify the effect of crystallographic orientation. (auth)

**20419** CRITICAL MAGNETIC FIELDS IN RARE EARTH ALLOYS. Belov, K. P.; Kataev, G. I.; Nikitin, S. A.; Solntseva, L. I. Compt. Rend. Acad. Bulg. Sci.; 27: No. 10, 1323-1326 (1974). (In Russian).

The magnetization curves were determined for two Er–Ho–Dy alloys at 4.2°K. The dependence of the critical field at 4.2°K on the composition was also evaluated. The temperature dependence of the critical field was measured for Er–Ho–Dy and Tb–Y alloys. (JSR)

**20420** CREEP BEHAVIOR OF SOME SILICON-CONTAINING TITANIUM ALLOYS. Winstone, M. R.; Rawlings, R. D.; West, D. R. F. (Imperial Coll. of Science and Tech., London). J. Less-Common Metals; 39: No. 2, 205-217(Feb 1975).

An investigation has been made of the secondary creep behavior of binary Ti–Si alloys containing ~0.6 and 1 wt.% Si and of a Ti–5 wt.% Zr–1 wt.% Si alloy. The Ti–1 wt.% Si alloy, as-quenched from the $\beta$-phase region, showed a high resistance to creep; this is associated with silicon in solid solution and the consequent dynamic strain aging effect arising from a silicon–interstitial atom interaction. The precipitation of $Ti_5Si_3$ by aging reduced the creep resistance. The presence of zirconium substantially improved the creep resistance in the aged condition. Values of the stress exponent at strain rates $>10^{-10}$ $s^{-1}$ were in the range 5 to 20, but showed no systematic variation with alloy composition or heat treatment. Values of the apparent activation energy for secondary creep depended on the silicon content, and were greater than those for diffusion of substitutional elements in titanium. (auth)

**20421** INFLUENCE OF THE PURITY VARIATIONS ON THE HIGH-TEMPERATURE CREEPING OF Cr–Mo–V STEELS. Balbi, M. (Politecnico, Milan); Nicodemi, W.; Paganini, L.; Bulckaen, V. Met. Ital.; 66: No. 10, 539-542(Oct 1974). (In Italian).

The influence of the purity on the creeping fracture of Cr–Mo–V steels at 550°C was tested both at normal microstructural conditions and under conditions like those in heat-affected zones of weldings. Results showed that purity improves fracture properties. The austenizing treatment of high-purity steels at a very high temperature leads to an improved elongation as well as to a higher fracture load. (auth)

**20422** OXYGEN SOLUBILITY AND KINETICS OF OXYGEN ABSORPTION IN NIOBIUM-RICH NIOBIUM-ZIRCONIUM-ALLOYS. Jehn, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart (F. R. Germany). Inst. fuer Werkstoffwissenschaften); Ortali, P. (Consiglio Nazionale delle Ricerche, Cinisello-Balsamo/Milan (Italy). Laboratorio per la Tecnologia dei Materiali Metallici non Tradizionali). Z. Metallk.; 65: No. 9, 586-592(Sep 1974). (In German).

9 figs.; 1 tab.; 29 refs.

The oxygen solid solubility limit in Nb–Zr alloys containing 2 and 5 at.-% Zr was investigated in the temperature range between 1,400 and 1,900°C. The oxygen concentration as a function of Zr content and temperature can be represented by the equation $\log c_s = -\frac{1}{2} \log c_{Zr} + 1.42 - 8{,}480/T$ (c in at.-%; T in degrees Kelvin). Furthermore the niobium-rich part of the ternary system Nb–Zr–Oxygen is discussed. Studies on the kinetics of oxygen absorption at 1,100 to 1,800°C and $2.10^{-5}$ to $1.10^{-3}$ torr oxygen yielded reaction coefficients between 0.2 and 0.7. During oxygen absorption, zones containing $ZrO_2$ precipitates are formed which grow from the surface to the center of the samples. (auth)

**20423** CALORIMETRIC DETERMINATION OF THE ENTHALPIES OF FORMATION OF SOME INTERMETALLIC COMPOUNDS. Dannoehl, H. D.; Lukas, H. L. (Max-Planck-Institut fuer Metallforschung, Stuttgart (F. R. Germany). Inst. fuer Werkstoffwissenschaften). Z. Metallk.; 65: No. 10, 642-649(Oct 1974). (In German).

10 figs.; 1 tab.; 19 refs.

A high-temperature calorimeter was constructed, which allows measurements of enthalpies of solution in liquid metals at temperatures up to 1,000°C. The enthalpies of solution of copper, iron, nickel, and uranium in aluminum and those of nickel and silver in tin were measured at 750°C. The enthalpies of formation of some intermetallic compounds were determined as follows: UAl –7.9 kcal/g-at., $UNi_2$ –7.7 kcal/g-at., $UNi_3$ –7.2 kcal/g-at., UFeAl –5.9 kcal/g-at., $Ni_3Sn_4$ –8.05 kcal/g-at. and $Ni_3Sn_2$ –9.23 kcal/g-at. Enthalpies of formation of solid solutions between $UFe_2$ and $UNi_2$ confirmed the results of King and Kleppa, that the enthalpy vs. concentration curve in quasibinary sections of ternary systems containing only Laves phases, is similar to the enthalpy vs. concentration curve in the corresponding binary system of the elements on the places of the smaller atoms in the Laves phases concerned. The enthalpy of the $\beta$-phase $Ni(1 \pm x)Al$ was measured as a function of concentration in the whole range of homogeneity. (auth)

**20424** INTERDIFFUSION OF NIOBIUM AND TANTALUM BETWEEN 1400 AND 2000°C. Weisweiler, W.; Nageshwar,

G. D. (Univ., Karlsruhe, Ger.). High Temp.–High Pressures; 6: No. 2, 229-236(1974).

Interdiffusion coefficients for the Nb–Ta system were determined on samples prepared by hot pressing a niobium plate between two tantalum plates. The diffusion profiles across these sandwich samples were obtained from penetration plots determined by electron microprobe analysis. For the evaluation of the interdiffusion coefficients, probability graphs were employed in preference to the Boltzmann–Matano method. With increasing niobium concentration, the interdiffusion coefficients follow an exponential relationship. The activation energy for the diffusion is linearly related to niobium concentration and averages ~ 74 kcal $mol^{-1}$. (auth)

**20425** RESISTIVITY OF LANTHANUM, PRASEODYMIUM, AND PRASEODYMIUM–TERBIUM ALLOYS IN D-HEX PHASE. Krizek, H. (Univ. of Durham, Eng.). J. Phys., F (London); 5: No. 1, 56-72(Jan 1975).

The influence of the crystal field on the electrical resistivity of Pr and the magnetically nondilute Pr–Tb alloys in the d-hex phase is analysed. The variation of the resistivity with the temperature is calculated using an expression derived by Maranzana and Bianchessi (Phys. Stat. Solidi; (b)43:601 (1971)) to the first order of the perturbation theory. The result of two sets of crystal field levels considered are discussed. The resistivity of La is discussed as phonon contribution to Pr and Pr–Tb alloys in d-hex phase. (auth)

**20426** COMMENTS ON THE MECHANICAL BEHAVIOUR OF MOLYBDENUM AND TANTALUM UNDER HIGH PRESSURES. Robbins, C. H.; Wronski, A. S. (Univ. of Bradford, Eng.). High Temp.–High Pressures; 6: No. 2, 217-221(1974).

To investigate the hypothesis of Nishihara et al. (High Temp.–High Pressures; 4: 281-291 (1972)) that dislocations introduced during testing under superposed hydrostatic pressures in the range 0.1 to 0.5 GN $m^{-2}$ suppress the yield point and lower the yield stress in polycrystalline molybdenum and tantalum, similar specimens were pressurized at 1.5 GN $m^{-2}$ and tested at atmospheric pressure. No reproducible significant effect of pressurization on the yield point phenomenon was found. Variations were found, however, owing to small differences in grain size, and on testing in different assemblies, particularly a 0.3 GN $m^{-2}$ pressure cell, whether at atmospheric or under superposed hydrostatic pressures. It is concluded that any pressure (0.3 GN $m^{-2}$) or pressurization (1.5 GN $m^{-2}$) effects on yielding are within experimental scatter and metallurgical and testing variables for the materials studied. (auth)

**20427** SUPERCONDUCTING TRANSITION TEMPERATURES OF CHEMICALLY VAPOR-DEPOSITED TUNGSTEN–RHENIUM ALLOYS. Easton, D. S.; Koch, C. C.; Kroeger, D. M.; Cable J. W. (Oak Ridge National Lab., TN). Phil. Mag.; 30: No. 5, 1117-1134(Nov 1974).

Superconducting transition temperatures ($T_c$) have been measured on a series of chemically vapour-deposited (CVD) tungsten-rhenium alloys. The samples were prepared by hydrogen reduction of tungsten and rhenium hexafluoride in the composition range 3.5 to 95 at.-% Re. The maximum $T_c$ found was 11.4 K at 42 at.-% Re which is considerably higher than the ~5 K reported for arc-melted W–Re in this composition range. The transition temperatures of as-deposited samples were higher than those of comparable arc-melted alloys for the entire composition range regardless of crystal structure. Two reasons suggested for the enhancement of $T_c$ are: (1) the formation of a $Cr_3Si$-type A15 structure, and (2) the presence of impurities trapped in the lattice. After high-temperature annealing the $T_c$ was decreased to that of arc-melted samples. This is attributed to the decomposition of metastable phases to the equilibrium structure and/or the precipitation of gas or gaseous compounds in the form of bubbles. Long-range order parameters of samples with the A15 phase were low and showed the unusual feature of exhibiting increasing order with increasing departure from stoichiometry. (auth)

**20428** SINGLE SUPERCONDUCTING ENERGY GAP IN PURE NIOBIUM. Novotny, V.; Meincke, P. P. M. (Univ. of Toronto). J. Low Temp. Phys.; 18: No. 1-2, 147-157(Jan 1975).

The quantities characterizing the superconducting behavior of very pure niobium determined from the specific heat measurement are $T_c = 9.26 \pm 0.01$ K, $C_{es} = (0.091 \pm 0.001)T^3$ below 3 K, $\Delta C(T_c) = 140 \pm 4$ mJ/mole K, $2\Delta(0)/kT_c = 3.65 \pm 0.04$, $H_c(0) = 2061 \pm 30$ G, and $dH_c/dT = 419.3 \pm 3$ G/K at $T = T_c$. Principal discrepancies with previous measurements are the absence of an anomalous specific heat at low temperatures in higher purity niobium and a sharp discontinuity at the superconducting transition temperature. A sample with lower purity exhibited an excess specific heat at temperatures below 2.3 K but of smaller magnitude than previously reported. (auth)

**20429** DAMPING EFFECTS AND FLUX KINETICS IN A TYPE II SUPERCONDUCTING DISK. Harrison, R. B.; Pendrys, J. P.; Wright, L. S. (Royal Military Coll. of Canada, Kingston, Ont.). J. Low Temp. Phys.; 18: No. 1-2, 113-123(Jan 1975).

Magnetooptic techniques coupled with high-speed cinephotography have been used to study flux jumps in a Nb–25% Zr superconducting disk triggered by the application of an external magnetic field. It is shown that the exponential time constant $\tau_u$ which characterizes the penetration of the magnetic flux and the flux jump field $H_{fj}$ is independent of the sweep rate of the applied magnetic field over three orders of magnitude. It is also demonstrated that magnetic coupling between the disk-shaped superconductor and a high-purity normal metal beneath it can significantly damp the motion of magnetic flux into the superconductor, thus enhancing its stability against flux jumps. (auth)

## Radiation Effects

*Refer also to abstract 21422.*

**20430** (AED-CONF-74-328-017) ION DAMAGE AND PHOSPHORUS DIFFUSION GETTERING OF Au IN Si. Seidel, T. E.; Meek, R. L.; Cullis, A. G. (Bell Telephone Labs., Inc., Murray Hill, N. J. (USA)). 1974. 10p. (CONF-740729-7). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

The residual disorder caused by different implanted ions after annealing at elevated temperatures (850-1, 150°C) is dependent upon the ion species. The gettering of Au by damaged layers produced by Ar, O, P, Si, As, and B has been quantitatively compared to gettering by phosphorus diffusion. Each individual comparison was made between opposite surfaces of a Si sample by use of Rutherford backscattering. The damage disorder was quantitatively measured by backscattering and structurally studied using electron microscopy. Ar ion damaged layers were more effective for gettering Au than were phosphorus diffused layers below approximately 1,000°C and equally effective up to 1,150°C. The relative gettering efficiency of the damage produced by other ions studied was less than that of phosphorus diffusion at 1,000°C and was ranked in the order Ar > = O > P > Si > As > = B. In general, the relative gettering efficiency of ion damaged layers was related to the amount and type of disorder after annealing. (auth)

**20431** (AGC-2743) FIRST IRRADIATION TEST OF STRUCTURAL MATERIALS. (Aerojet-General Corp., Azusa, Calif. (USA)). 15 Apr 1963. 322p. Dep. NTIS $19.25.

Four metals and seven organic materials were tensile tested during immersion in liquid hydrogen, before and after exposure to nuclear radiation. Total dose for metals was $2 \times 10^{17}$ nvt (E > 0.33 MeV). Organic materials were exposed at two dose levels: $4 \times 10^8$ ergs/gm (C) and $5 \times 10^8$ ergs/gm (C). (It is understood that standard dose units are being established for use on the NERVA Program, but this information was received too late for incorporation in this report). Evaluation of the materials included electron microscopy, x-ray diffraction, metallography, and chemistry. The metals tested were: Titanium Alloy Al10-AT (5Al–2.5Sn) grade ELI, and stainless steels types 304, 347, and 17-7PH (RH 950), including welded specimens of Al10-AT and type 347. The organic materials were Teflon, Armalon (Teflon-impregnated glass laminate), Rulon A (fiberglass-filled Teflon), phenolic-asbestos, phenolic-linen, phenolic-glass, silicone-glass. Results indicate that for this dose, metal properties will not be altered significantly from the engineering standpoint, except possibly for the ductility of Al10-AT, which requires additional testing. Of the four metals, 17-7PH (RH 950) is not recommended for –423°F service. Results of tests on organic materials indicate varying degrees of degradation as expected. However, a significant increase was noted in the threshold for damage to tensile strength of Teflon base materials. (auth)

**20432** (ANL-Trans-965) IRRADIATION OF SODIUM-BONDED URANIUM AND PLUTONIUM CARBIDES: CARBURIZATION OF CLADDINGS. Mikailhoff, H.; Housseau, M.; Erler, J. Dec 1974. Translation of a French Paper. 11p. Dep. NTIS $4.00

Results of metallographic studies show that, at 610°C, stainless steel cladding clearly undergoes more extensive and rapid carburization than that expected from out-of-pile tests. Carburization is considerably less at 500°C (both in degree and rate). These results show that carbon transport takes place preferentially toward the hottest zone of the cladding and that irradiation must probably accelerate carbon diffusion in the steel and the carbide. Tensile tests at the irradiation temperature were performed with specimens from cladding CA6 (most highly carburized steel). The variation of the elastic limit with temperature is essentially the same as that observed in the cladding of the driver fuel of

RAPSODIE (Type 316 stainless steel clad-mixed oxide fuel) irradiated at the same fluence, and the ductility values are similar, with a fairly wide scatter, as those measured normally. Thus, carburization does not seem to modify the mechanical strength of the cladding nor cause embrittlement. This agrees with the estimates of American researchers who consider 0.7% to be the minimum carbon content to obtain a loss of mechanical properties in steel. (auth)

**20433** (CEA-CONF-2706) IRRADIATION-INDUCED EMBRITTLEMENT OF STEELS FOR NUCLEAR REACTOR VESSELS. Petrequin, P.; Soulat, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Technologie). 1974. 41p. (In French). (CONF-740688-1). Dep. NTIS (US Sales Only) $5.25.

From 17th colloquium on metallurgy, mechanical and metallurgical factors of rupture in nuclear industry; Saclay, France (24 Jun 1974).

Steels become brittle when exposed to neutron irradiation. This phenomenon is especially pronounced in the case of ferritic steels which show a ductile transition. Neutron irradiation causes a hardening (increase in the elastic limit) associated with an embrittlement, a rise in the transition temperature and a reduction of the resilience. After a brief examination of the chief mechanisms responsible for this embrittlement, results obtained on reactor vessel steels are presented showing the effects of the irradiation temperature, the neutron dose, and the metallurgical characteristics of the materials such as metallurgical structure and chemical composition. Problems of the prediction of irradiation-induced embrittlement are discussed, in terms of the choice of specimens and methods. (FR)

**20434** (COO-1367-62) EFFECT OF POINT DEFECTS ON MECHANICAL PROPERTIES IN METALS. Technical Progress Report, January 1, 1974 to December 31, 1974. Meshii, M. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Materials Science). [nd]. Contract AT(11-1)-1367. 11p. Dep. NTIS $4.00.

The primary attention of the present project during the past year was directed toward the effect of electron irradiation on the plastic deformation of iron single crystals. The orientation dependence of the irradiation softening was extensively investigated (COO-1367-57 and COO-1367-58). The investigation of the microyielding behavior of irradiated iron has been completed and written up (COO-1367-61). The results supplemented the macroyielding results and revealed interesting dislocation activity in the pre-macroyielding region. A number of observations regarding electron irradiated iron and the mechanism determining the strength of iron were organized and were reported at the Kyoto Symposium (COO-1367-59). The effect of carbon atoms was also investigated in iron to compare the effect of self-interstitials produced by electron irradiation; the details of this investigation are being published (COO-1367-60). The dislocation motion was studied over a temperature range between 4.2 and 100°K in copper single crystals irradiated at 100°K; the emphasis was to examine how the dislocation motion revealed by etch pits correlates with the macroscopic stress-strain relation. (auth)

**20435** (HEDL-TME-71-77) SEMI-ANNUAL PROGRESS REPORT. Heavy Section Steel Technology Program for the Period Ending February 28, 1971. Williams, J. A.; Hunter, C. W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1971. Contract AT(45-1)-2170. 20p. Dep. NTIS $4.00.

Studies were made of the effects of ETR irradiations by fast neutrons on the fracture toughness and tensile properties of ASTM A533, Grade B, Class I steel from HSST plate 02. (DLC)

**20436** (JUL-1100-FF) RADIATION ENHANCED DIFFUSION IN Cu-Ni ALLOYS AT TEMPERATURES FROM 25 K UP TO 600 K. Poerschke, R. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung). Aug 1974. 153p. (In German). Dep. NTIS (US Sales Only) $10.75.

Thesis. Submitted to Technische Hochschule Aachen, West Germany.

The residual resistivity of alloys with Ni contents between 42 and 71 at. % has been investigated during electron irradiation at 25 to 573°K as well as during isochronal annealing at 670°K. During irradiation at 25, 82, and 95°K the resistivity increases-probably due to the point defect production. Significant resistivity recovery starts at about 90°K leading to total recovery at temperatures between 120 and 200°K depending on alloy composition. At higher temperatures the resistivity decrease still proceeds causing strong negative resistivity changes being due to alloy decomposition. From the observed decomposition temperature it is concluded that the required mass transport is due to interstitial migration. In the temperature region from 120 to 373°K the decomposition kinetics observed during electron irradiation in an alloy with 58.7 at. % Ni can be explained quantitatively by an interstitial diffusion model in which it is assumed that the average interstitial diffusion path is determined by trapping and recombination reactions. The effective trap concentration and the recombination radius of the vacancy are found to decrease with increasing temperature. A quantitative evaluation of the temperature dependence leads to the conclusion, that in Cu-Ni alloys electrostatic and/or electromagnetic forces may play a role for the interaction of interstitials and vacancies. Recovery experiments show that the vacancies must be mobile at temperatures above 300°K. Above 420°K the migration of the vacancies leads to significant interdiffusion compared with the interdiffusion produced by interstitial migration. (auth)

**20437** (KFK-2040) INFLUENCE OF PRETREATMENTS UPON THE CREEP-RUPTURE-STRENGTH AND CREEP-BEHAVIOR OF STAINLESS STEEL X8 CrNiMoVNb 1613. Schirra, M. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Oct 1974. 71p. (In German). Dep. NTIS (US Sales Only) $6.75.

The austenitic stainless steel X8 CrNiMoVNb 1613 (DIN-W.Nr. 1.4988) was given 17 different pretreatments and tested in 600 to 750°C temperature range for its creep-rupture-strength and creep-behavior. The use of different specimen forms and testing in air and vacuum allow statements to the effect of specimen form and test-atmosphere. Starting with material in solution annealed and aged at 750°C-condition, the effect of cold-working (5 to 50%) along with that of various aging treatments (700 to 850°C, 1 to 170 hours) on the creep-rupture strength and creep-behavior and on ductility is reported. It should be noted, that the yield strength should essentially be increased to meet the requirements placed on the fuel-element cladding of a fast breeder reactor. For the austenitic steels being considered as the potential material for the cladding, an increase in their yield-strength can only be achieved by cold-working or by giving a suitable thermomechanical pretreatment. Among the various pretreatments employed in the investigation, solution-annealing + 5% cold work + aging at 800°C - 1 hour/air was found to be the optimum pretreatment for the X8 CrNiMoVNb 1613 steel. (auth)

**20438** (NRL-Report-7770) FATIGUE RESISTANCE OF TYPE 348 STAINLESS STEEL UNDER SIMULATED WATER REACTOR CONDITIONS. Smith, H. H.; Shahinian, P. (Naval Research Lab., Washington, D. C. (USA)). 26 Jun 1974. 16p.

The effects of neutron irradiation and high-temperature water-vapor environment on the fatigue behavior of Type 348 stainless steel were investigated. At 550°F (288°C), fatigue life and crack-growth rate comparisons were made of irradiated and unirradiated sheet specimens as a function of total strain amplitude. The tests were conducted in reverse bending at a constant amplitude of vibration in dry air, in water vapor, and in vacuum. Tests in water vapor were designed to simulate water-cooled reactor environments. Notched specimens were cycled at resonance, and crack-growth rates were determined by a method that relates changes in the frequency of vibration to crack growth. Neutron irradiation to a fluence of $1.5 \times 10^{21}$ n/cm$^2$ > 0.1 MeV at an irradiation temperature of approximately 550°F (288°C) produced an increase in fatigue life in all test environments. The magnitude of the effect was dependent on strain, and in air life was increased by a factor of ten at high strains (0.20%); but at lower strains (0.13%) the fatigue life of irradiated samples appeared to approach an endurance limit and was greatly extended. The general improvement in fatigue life for the irradiated condition was attributed mainly to decreased crack-growth rates. The fatigue life of this steel, when unirradiated, was longest in vacuum, was less in water vapor, and was least in air. When irradiated, the steel had a longer life, which was greatest in water vapor and vacuum, and again the shortest in air. Results indicate that the fatigue performance of reactor components made of Type 348 stainless steel should not be adversely affected by the environment found in water-cooled reactors. (auth)

**20439** (ORNL-TM-1535) COMPARISON OF DISPLACEMENT DAMAGE AND STRENGTH FOR STAINLESS STEEL IRRADIATED AT INTERMEDIATE TEMPERATURES. Bloom, E. E.; Stiegler, J. O.; Martin, W. R.; Weir, J. R. (Oak Ridge National Lab., Tenn. (USA)). Jun 1966. Contract W-7405-eng-26. 22p. Dep. NTIS $4.25.

The effects of irradiation at temperatures between 93 and 454°C on the room-temperature mechanical properties and electron microstructures of AISI type 304 stainless steel have been determined. Irradiation at temperatures between 93 and 300°C produces a high density of defect clusters on the order of 100 Å in diameter. These defects are responsible for the increased yield stress, for when the irradiation temperature was increased to 371°C, no defect clusters were observed and the yield stress decreased by a factor of 2. At irradiation temperatures of 371°C and higher,

precipitates formed within the grains. Deformation (10% by rolling) in a specimen containing the defect clusters was concentrated in very narrow slip bands, while in the specimen containing precipitate particles, the deformation was homogeneous. (auth)

**20440** (RD/B/M-3125) IRRADIATION INDUCED EFFECTS IN ZIRCONIUM (A REVIEW). Madden, P. K. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Aug 1974. 19p. Dep. NTIS (US Sales Only) $4.00.

The technique of using transmission electron microscopy (TEM) to examine microstructural changes in zirconium and its alloys is reviewed. It is apparent that a controversy exists concerning the identity of the irradiation induced dislocation loops formed in zirconium during low doses of irradiation ($\lesssim 10^{26} ncm^{-2}$). Some workers are confident that no loops exist with non-basal Burgers vectors, while others are convinced that at least 5% of the loops do have non-basal Burgers vectors. Uncertainties exist about the vacancy or interstitial character of these loops. Thus TEM experimental evidence does not give definite support for any of the models proposed to explain the irradiation growth phenomenon, i.e. volume conserved shape change during irradiation, observed in zirconium. At higher doses of neutron, $Ni^+$ ion, and electron irradiation, aligned defect formation has been observed. In each case, the dose levels and temperature regimes are not identical, and it remains to be shown that the aligned defects in each of these irradiations are in fact the same. Finally the resistance shown by zirconium to void formation has been investigated. Up to 1973 no voids were observed in irradiated specimens but recent experiments show that voids do form in pure zirconium and furthermore that enhanced void swelling may be obtained in the presence of gaseous impurities. (auth)

**20441** (RN-S-0290) FINAL REPORT. GTR-16 RADIATION EFFECTS TEST ON STRUCTURAL MATERIALS AT −423°F. Weleff, W.; Dixon, C.; Bauer, J.; Dessau, P.; Matt, R. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1966. 209p. Dep. NTIS $13.50.

Results of radiation testing on structural materials conducted for the NERVA Program are summarized. Data pertaining to structural materials; ultimate and yield tensile strength, reduction of area, elongation, stress-strain, notched tensile strength, notched-to-unnotched strength ratio, and shear strength are presented. Materials tested include Al-base alloys, stainless steels, Hastelloy, Inconel, and Ti-base alloys. Control and irradiation data are also included for three types of bearing retainers. These retainers were made of Armalon containing FEP Teflon, or TFE Teflon. The irradiated specimens received a maximum integrated fast neutron exposure of $6 \times 10^{16}$ nvt (E > 1.0 MeV) and $1 \times 10^{17}$ ergs/gr(C) while immersed in $LH_2$. Both control and irradiated specimens were tested at room temperature. (auth)

**20442** (RN-S-0401A) STATISTICAL CORRELATION OF GTR-19 LIQUID HYDROGEN AND LIQUID NITROGEN IRRADIATION DATA FOR STRUCTURAL MATERIALS. Springer, H. L.; Bauer, J. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1968. 41p. Dep. NTIS $5.25.

A statistical analysis is presented of the effects of radiation on the mechanical properties of structural materials irradiated in liquid hydrogen. Radiation effects on identical materials irradiated in liquid nitrogen are compared. The structural materials irradiated during GTR-19 test 37R007 were aluminum 6061-T6, titanium alloy Ti 5Al 2.5 Sn-ELI, Hastelloy X, Inconel 718, A-286 steel, and AISI-347 stainless steel parent metal and welds. Neutron fluence was approximately $3 \times 10^{17}$ nvt (E > 1.0 Mev). The results lead to the conclusion that the mechanical properties of certain metals after irradiation at liquid hydrogen temperature can be predicted from properties of the metal measured before and after irradiation at liquid nitrogen temperature. (auth)

**20443** (RN-S-0520) GTR-19 TEST TO DETERMINE CRYOGENIC RADIATION EFFECTS ON STRUCTURAL MATERIALS. Final Report. Stadig, J. E.; Dixon, C. E.; Davidson, M. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1969. 98p. Dep. NTIS $8.00.

Ten structural alloys in 23 different forms were irradiated and tested in liquid nitrogen to neutron fluences of approximately $10^{18}$ nvt > 1.0 MeV. In addition, seven structural alloys were irradiated and tested in liquid hydrogen and liquid nitrogen to neutron fluences of approximately $3 \times 10^{17}$ nvt > 1.0 MeV. The materials generally exhibited significant increases in yield strength and notched strength, minor increases in ultimate strength, and decreases in elongation that varied in significance. The performance of Ti 5Al 2.5Sn was an exception; the notch strength decreased significantly. In some cases, the magnitude of radiation effects was found to be significantly influenced by the form of the material. The property changes detected after irradiation in liquid nitrogen and in liquid hydrogen were essentially the same when compared on the basis of percent change in the property from that of the unirradiated value. The most significant exception was the change in yield strength for Al 6061-T6; the percent change in yield strength was more than twice as great in liquid hydrogen as in liquid nitrogen. (auth)

**20444** (RN-S-0553) CRYOGENIC RADIATION EFFECTS ON ALUMINUM 7039 AND HASTELLOY X GTR-21 TEST 37R018. Final Report. Davidson, M. J.; Brown, D. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1970. 49p. Dep. NTIS $5.50.

Hastelloy X and Al alloy 7039 in six different forms were irradiated to neutron fluences of approximately $1 \times 10^{17}$ nvt > 1.0 MeV and subsequently tensile tested. During irradiation and testing, the specimens were submerged in liquid nitrogen to maintain the desired cryogenic temperature. Selected specimens were annealed for one hour at 440 or 540°R prior to tensile testing in liquid nitrogen. Results are tabulated and analyzed. (auth)

**20445** (RN-TM-0149) NERVA TURBOPUMP BEARING ASTR-4A AND ASTR-5 TESTS. Final Report. Accinelli, J. B.; Andrews, F. X.; Cunningham, R. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 22 Jan 1965. 43p. Dep. NTIS $5.25.

Results are presented of two bearing tests each operated for 60 accumulated minutes in the nuclear environment produced by a 10 megawatt Aerospace System Test Reactor (ASTR) operating at full power. Both bearings satisfactorily completed the scheduled 60 minute irradiation runs; yet in each test the armalon retainer of the thrust bearing failed. Results of the failure and effect of the radiation on the retainers is presented. A comparison is made to armalon retainers coated with Molykote 321 considered excellent candidates for the present turbopump requirements and engine system tests. (auth)

**20446** (TID/SNA-41) MULTIPLE REGRESSION ANALYSIS OF CONSOLIDATED RADIATION EFFECTS DATA, NERVA MATERIALS TENSILE PROPERTIES OF INCONEL 718 (PARENT METAL) AT HIGH TEMPERATURES (1200-2000°R). Lev, M. S.; Springer, H. L. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Aug 1970. 76p. Dep. NTIS $7.00.

Data on radiation effects on the tensile properties of Inconel 718 at 1250 to 2000°R are presented. Results obtained in various radiation effects test programs were fitted to multiple regression models to yield prediction equations for this alloy. Numerical results are presented in tables and charts. (JRD)

**20447** (TID/SNA-56) s110-XAN08-W181F1: s110 RADIATION EFFECTS ANALYSIS REPORT-NOZZLE. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1970. 24p. Dep. NTIS $4.25.

An analysis of the availability of data for the candidate nozzle materials with respect to the anticipated nuclear environment and the properties required for design has been completed. The information required to complete the acquisition of suitable data has been outlined on the appropriate Radiation Effects Information Request (REIR) forms. Previous reactor tests have supplied information on tensile properties within the general fluence/temperature range of the NERVA requirements for the nozzle candidate materials except for ARMCO 22-13-5. Each test was small in scope and served to provide answers for particular situations. None of the tests provides sufficient experience comparable to the properties and fluences dictated by the presently specified NERVA engine useful life which is 10 hours. Fatigue properties at elevated temperatures are required for nozzle tube sheet material. This property has not been evaluated for the irradiated materials. Non-irradiation fatigue tests in progress will determine whether a sufficient margin in fatigue strength exists to preclude testing irradiated tube materials. Environmental test conditions for 347 stainless steel, Hastelloy X and ARMCO 22-13-5 are outlined. (auth)

**20448** (TID/SNA-57) s110-XAV12-W181f1: RADIATION EFFECTS ANALYSIS REPORT, PRESSURE VESSEL AND CLOSURE. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1970. 22p. Dep. NTIS $4.25.

An analysis of the availability of data for the candidate pressure vessel and closure materials with respect to the anticipated nuclear environment and the properties required for design has been completed. The information required to complete the acquisition of suitable data has been outlined on the appropriate Radiation Effects Information Request (REIR) forms. Information is included on radiation effects on Al-base alloys and on Ni−Co alloys. (JRD)

**20449** (TID/SNA-137) s110-MX01-W181-7f: TENSILE PROPERTIES OF WASPALOY (PARENT METAL). Multiple Regression

Analysis of Consolidated Radiation Effects Data, NERVA materials. Lev, M. S. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Jun 1970. 42p. Dep. NTIS $5.25.

The effects of radiation on tensile properties of waspaloy are reported for a range of fast and thermal neutron fluences and temperatures. The data were obtained by fitting multiple regression equations to available numerical results. (JRD)

**20450** (TID/SNA-260) s110-GTR21-W183: FINAL REPORT, GTR-21 TEST 37R017. High-Temperature Radiation Effects on Rene 41, Waspaloy, and Inconel 718. French, W. E.; Brown, D. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). May 1970. 91p. Dep. NTIS $7.75.

Results show that in Rene 41, Waspaloy, and Inconel 718 forgings, the tensile property most sensitive to radiation was elongation, which exhibited moderate to large decreases for nearly all test conditions. The damage threshold for elongation decrease at 1660°R and above is below $10^{18}$ n/cm² < 0.48 eV for all materials. The 0.2% offset yield strengths did not show a significant change. Irradiation did not affect the stress-strain curves except to interrupt them at a lower strain due to fracturing, thus lowering the elongation. For those test conditions in which the work hardening was not complete, premature fracture reduced the ultimate strength. Reduction of area and engineering fracture stress were usually changed due to premature fractures. Elongation damage appears to react its maximum at the higher fluences. The two alloys tested in stress rupture showed significant reductions in time-to-failure, elongation and reduction of area. Inconel 718 showed severe notch sensitivity in stress rupture. At 1760°R all irradiated notched specimens failed in the notched area; mean time to failure after 1.59 n/cm² < 0.48 eV exposure was 1.4 hours. (auth)

**20451** (TID/SNA-269) t119-X2CD1-W181f3: CRYOGENIC RADIATION EFFECTS, Ti-5Al-2.5SnELI FORGING. Final Report, GTR-20C Tests 37NRO 028A and 029A. French, W. E.; Brown, D. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Feb 1971. 64p. Dep. NTIS $6.25.

Ti 5Al 2.5Sn ELI forging in two forms (tensile and fracture toughness) was irradiated to three fluences (approximately $3 \times 10^{17}$ n/cm², $1 \times 10^{18}$ n/cm² and $6 \times 10^{18}$ n/cm² > 1 MeV) and subsequently tensile and fracture toughness tested. During irradiation and testing, the specimens were submerged in liquid nitrogen to maintain the cryogenic temperature. Selected specimens (4 tensile and 4 fracture toughness irradiated to a fluence of $6 \times 10^{18}$ n/cm² > 1 MeV) were annealed for 100 minutes at 540°R prior to tensile and fracture toughness testing in liquid nitrogen. During the annealing period resonant frequency measurements were conducted on the four high fluence tensile specimens. The Ti 5Al 2.5Sn ELI forging tensile property most sensitive to radiation was elongation, which exhibited significant decreases at fluences of $1 \times 10^{18}$ n/cm² > 1 MeV and above. No significant ductility loss was experienced at a fluence of $3 \times 10^{17}$ n/cm² (>1 MeV). A minor increase in elongation was measured due to annealing at 540°R for 100 minutes after irradiation to a fluence of $6 \times 10^{18}$ n/cm² > 1 MeV. A significant decrease in fracture toughness occurred in specimens irradiated to a fluence of $1 \times 10^{18}$ n/cm² (>1 MeV). No significant change in fracture toughness property in specimens irradiated to a $2.8 \times 10^{17}$ n/cm² (>1 MeV) was observed. In three of four Ti 5Al 2.5Sn ELI forging tensile specimens irradiated to a fluence of $6 \times 10^{18}$ n/cm² (>1 MeV) a significant reduction in Resonant Frequency, HZ, was observed. (auth)

**20452** (TID/SNA-638) CRYOGENIC RADIATION EFFECTS ON AISI 347 STEEL FORGING. Final Report, GTR-20C. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Mar 1971. 56p. Dep. NTIS $6.00.

Tensile button-head specimens from a AISI 347 forging were irradiated to three fluences ($6 \times 10^{17}$, $10^{18}$, and $5 \times 10^{18}$ n/cm² > 1 MeV) and tensile tested at 140°R. Nine specimens irradiated to $5 \times 10^{18}$ n/cm², were annealed at 540°R for 10, 100, or 1000 min prior to tensile testing at 140°R. The tensile property most sensitive to radiation was 0.2% offset yield strength, which increased significantly for each fluence. This property also decreased for each annealing period. Ultimate strength increased for all fluences; annealing produced no significant changes. For elongation and reduction of area, no significant changes were produced by irradiation and annealing. For the fluence of $5 \times 10^{18}$ n/cm², a significant reduction in resonant frequency was observed, indicating a small decrease (2%) in Young's modulus. (DLC)

**20453** MONOCLINIC, CrB-RELATED, CRYSTAL STRUCTURE OF $Tb_3Ni_2$, $Dy_3Ni_2$, AND $Ho_3Ni_2$. Moreau, J. M.; Paccard, D.; Parthe, E. (Univ., Geneva). Acta Crystallogr., Sect. B; 30: No. 11, 2583-2586(15 Nov 1974).

$Dy_3Ni_2$ is monoclinic, space group C2/m, with a = 13.321, b = 3.662, c = 9.512 Å, β = 105.72°, Z = 4. $Tb_3Ni_2$ and the low-temperature modification of $Ho_3Ni_2$ are isotypic. The structure was solved by Patterson methods followed by a full-matrix least-squares refinement to an R of 0.08 for 538 counter reflexions. The structure is characterized by rare-earth trigonal prisms centered by Ni atoms. These prisms are similar to those found in the CrB-type structure and their arrangement is related to the CrB-type configuration. (auth)

**20454** DOSE RATE EFFECTS IN INDIUM IMPLANTED GaAs. Tinsley, A. W.; Stephens, G. A.; Nobes, M. J.; Grant, W. A. (Univ. of Salford, Eng.). Radiat. Eff.; 23: No. 3, 165-169(1974).

Lattice disorder produced by 40 keV indium ions has been studied using conventional channeling and Rutherford backscattering of 2.0 MeV helium ions. Plots of lattice disorder as a function of dose are nonlinear and sigmoidal in shape. The lattice disorder saturates for doses approaching $10^{14}$ ions · cm$^{-2}$; the higher the implantation dose rate, the higher this saturation level becomes. By varying the nominal dose rate between $2 \times 10^{10}$ ions.cm$^{-2}$.s$^{-1}$ and $10^{13}$ ions · cm$^{-2}$ · s$^{-1}$ a series of damage build up curves may be obtained. The dose rate effects can be described by the Vook and Stein (Radiation Effects; 2 : 23 (1969)) model of annealing during irradiation. Direct observation of implantation beam annealing strongly supports this model. Electron diffraction data indicate that no amorphous gallium arsenide phase is produced under the implantation conditions prevailing in this investigation. The dose rate effects together with the room temperature annealing of implanted samples and the behavior of several "warm" substrate implants lead to the conclusion that room temperature lies within a damage annealing stage for implanted gallium arsenide. Results of high energy implants indicate that the surface proximity of these low energy implants is also an important factor in their annealing behavior. (auth)

**20455** ELECTRON EXCITATION BY CHANNELLED PARTICLES IN A CRYSTAL. Thompson, M. W.; Pabst, H. J. (Univ. of Sussex, Eng.). Radiat. Eff.; 23: No. 2, 127-130(1974).

A method of calculation is presented for the yield of an electron excitation process by a channelled particle in a single encounter with an atomic row or plane in a crystal. It is shown that if $\phi$ is the initial angle between the ion trajectory and the row or plane, the number of inner-shell electrons excited is an increasing function of $\phi$ whereas the number of outer electrons excited may decrease with increasing $\phi$. (auth)

**20456** DEUTERIUM LATTICE LOCATION IN Cr AND W. Picraux, S.T.; Vook, F.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. Lett. 33: No. 20, 1216-1220 (11 Nov 1974).

Direct determination of the lattice location of implanted deuterium in single-crystal chromium has been made for the first time. Ion-channeling measurements of the angular distributions along the ⟨100⟩ axial and {100} planar directions indicate that implanted D occupies the octahedral position in bcc Cr. This contrasts to the expected tetrahedral interstitial position recently observed under the same conditions for bcc W. These results further clarify the apparent anomaly in the thermodynamic data for hydrogen solubility in Cr. (auth)

**20457** GROWTH AND COALESCENCE OF VOIDS IN IRRADIATED METALS. Mansur, L. K. Ithaca, New York; Cornell Univ. (1974). 125p. University Microfilms Order No. 74-29,925.

Thesis (Ph. D.).

A physical model has been developed to understand the kinetics of radiation induced void growth and coalescence. This model has been successful in describing experimental data on solution annealed 304 and 316 stainless steels, as well as other materials irradiated with neutrons, ions, and electrons over wide ranges of dose rate and temperature. The early part of the dissertation provides essential background on irradiation induced void growth and the associated swelling. The importance of controlling this phenomenon to current development efforts in fast reactor technology is reviewed. Understanding the fundamental processes of void swelling should contribute to the engineering solution of this problem and this serves as the motivation for the current work. At present there exists an extensive literature on the phenomenology of radiation induced swelling. Since these data must be used to test theoretical work, a brief description of the characteristics of voids and the dependence of swelling on irradiation variables and materials variables is given. The physical bases, essential equations, and predictions of existing theoretical formulations of void growth kinetics are reviewed. It is pointed out that the work is based on an alternative to a very basic assumption of these existing models. It is further pointed out that void coalescence should be taken into account in attempting to understand swelling behavior. A model for radiation swelling is presented in which void growth is rate limited at the void surface rather than by long range diffusion of point defects, and void coalescence takes place

according to geometrical probability. This model is developed, compared with experimental data and its implications analyzed. (Diss. Abstr. Int., B)

**20458** IRRADIATION HARDENING AND ANNEALING IN COPPER AT HIGH NEUTRON FLUENCES. Howe, L. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Eff.; 23: No. 3, 181-195(1974).

Irradiation hardening was investigated in copper crystals irradiated at ~325 K with $4 \times 10^{20}$ and $8 \times 10^{20}$n $cm^{-2}$. In the as-irradiated crystals, cleared channels were produced due to the sweeping up of the irradiation damage by the glide dislocations. The slip band width, spacing and height all increased with increasing testing temperature. Identical post-irradiation annealing treatments produced a larger fractional recovery of the critical resolved shear stress at 4 K than at 295 K. This indicates that the damage removed in the early stages of annealing acts as a more effective obstacle to dislocation glide at 4 K than at 295 K. For certain combinations of annealing treatment and low temperature testing, the initial stage of deformation was characterized by the bowing of the glide dislocations around the defects rather than sweeping them up. In polycrystalline copper, migrating grain and twin boundaries were quite effective in sweeping out the irradiation-produced defects. (auth)

**20459** HELIUM IMPLANTATION BY $He^+$ BOMBARDMENT OF TITANIUM DURING DEPOSITION FROM THE VAPOR PHASE. Venker, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiat. Eff.; 23: No. 3, 209-210(1974).

The high-temperature mechanical properties of reactor materials are strongly influenced by helium resulting from $(n,\alpha)$-reactions (high temperature embrittlement). Bombardment with high energy $He^+$ ions from particle accelerators is a classical way to implant helium, but it is difficult to obtain a homogeneous distribution of He in samples which exceed a certain size. Ti was bombarded during deposition from the vapor phase with $He^+$ ions being accelerated in the cathodic fall of an anomalous glow discharge. The energy taken up by $He^+$ under these conditions is in the order of $10^3$ eV, sufficient to penetrate about 200 Å into the material just deposited. Since deposition and bombardment are taking place simultaneously, it was expected that a homogeneous distribution of He could be obtained. The experimental procedure is explained, and the results are given. (auth)

**20460** PROTON CHANNELING USE FOR DETERMINING BORON ATOMS POSITION IN THE TUNGSTEN LATTICE. Skakun, N. A.; Matyash, P. P.; Dikii, N. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 10, 1610-1613(Oct 1974). (In Russian).

The phenomenon of charged particle flux redistribution in the channel is used to determine the boron atoms position in the tungsten lattice. Boron is shown to be an implantation impurity and to occupy octahedral interstitials. (auth)

**20461** DIRECTIONAL-ORDER ANISOTROPY ENERGY INDUCED BY NEUTRON IRRADIATION AND ITS TEMPERATURE DEPENDENCE IN Ni–Cr 5%. Allia, P.; Soardo, G. P. (Instituto Elettrotecnico Nazionale Galileo Ferraris, Turin). Lett. Nuovo Cim.; 11: No. 15, 665-667(14 Dec 1974).

Results are reported on directional ordering in a NiCr 5% (atomic) alloy, with a $T_c$ of ~190°C, produced by fast neutrons under a saturating magnetic field at ~60°C. The anisotropy energy $K_u$ is plotted vs temperature along with the straight and cube power of the saturation magnetizations. (DLC)

**20462** ANNEALING OF DAMAGE PRODUCED BY COPPER ION IMPLANTATION OF SILICON SINGLE CRYSTALS. Chadderton, L. T.; Whitton, J. L. (Univ. of Copenhagen). Radiat. Eff.; 23: No. 1, 63-66(Sep 1974).

A report is presented on the implantation of silicon with copper ions, to a total fluence in excess of that required for amorphization, followed by annealing up to 800°. It leads to anomalously high residual disorder as detected by Rutherford scattering and transmission electron microscopy. Absence of clearly identifiable precipitates similar to those seen in copper-diffused silicon suggests a physical or chemical inhibition of the recovery of damage on the near atomic scale. (UK)

**20463** SCATTERING AND RADIATION DAMAGE FOR LIGHT KEV IONS ON SOLID SURFACES. Robinson, J. E. (McMaster Univ., Hamilton, Ont.). Radiat. Eff.; 23: No. 1, 23-36(Sep 1974).

A Monte-Carlo numerical technique is used to calculate scattering coefficients, energy spectra, project range distributions, and damage distributions for H–Nb scattering over a reduced energy range $1 < \epsilon_0 < 10$. A limited number of D and He scattering cases are also considered. The numerical calculations are compared to the Weissmann and Sigmund (Rad. Effects; 19: 7 (1973)) integro-differential equation solutions for range and damage. Results are in quantitative agreement with the third-order Edgeworth expansion solution; however, corrections due to the free surface effect are found to be important for both scattering and damage. The Monte-Carlo calculations are also used to interpret recent sputtering results for H, D, and He incident on Nb. (auth)

**20464** CHANGE OF THE STATE OF THE MARTENSITE CRYSTALLINE STRUCTURE OF CARBON STEEL DURING IRRADIATION WITH HIGH ENERGY PARTICLES. Kritskaya, V. K. Metallofizika; No. 54, 31-34(1974). (In Russian).

New martensite states of carbon steel irradiated with high-energy particles were studied by x-ray structural methods. The characteristics of reverse processes of C redistribution in the lattice of the irradiated martensite at low temperatures were investigated. The causes for the increased stability at room temperature of the supersaturated solid solutions in the presence of increased concentration of radiation defects were examined. (tr-auth)

**20465** ION IMPLANTATION. An Annotated Bibliography. Agajanian, A. H. (IBM Components, Hopewell Junction, NY). Radiat. Eff.; 23: No. 2, 73-126(1974).

A literature search on ion implantation was performed and a bibliography with annotations of 295 references was compiled to update existing bibliographies. Physical Abstracts and Electrical and Electronics Abstracts of January 1972 to February 1973 were the sources used for this search. The bibliography was divided into eleven sections: books and review articles; range distribution and concentration profile; location of ions in the lattice; channeling and dechanneling; radiation damage and annealing; compound semiconductors; structural characterization; electrical characterization; device applications; equipment and ion sources; and miscellaneous. (auth)

**20466** EFFECT OF ELECTRON IRRADIATION ON UNALLOYED GALLIUM ANTIMONIDE. Abrikosov, N. Kh.; Kolokol'tsev, V. N.; Skudnova, E. V. Fiz. Khim. Obrab. Mater.; No. 6, 21-24 (1974). (In Russian).

The effect of fast electron irradiation at 2.2 MeV at 300°K on the basic electrophysical properties of unalloyed gallium antimonide was studied. The irradiation doses were $1 \times 10^{16}$ to $2 \times 10^{18}$ $cm^{-2}$. The measurements were made at 300 and 77°K. The dependences of the Hall coefficient, specific resistance, and Hall mobility of holes on the radiation dose were determined. It was established that at doses above $8 \times 10^{17}$ $cm^{-2}$ the character of the dependence of the electrophysical properties on the dose changed substantially. This change is connected with the high concentration of radiation defects. (tr-auth)

**20467** RADIATION-INDUCED DIFFUSION OF POINT-DEFECTS DURING LOW-TEMPERATURE ELECTRON IRRADIATION. Urban, K.; Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phil. Mag.; 30: No. 6, 1395-1418 (Dec 1974).

Electron irradiation damage in lead was studied in a high-voltage electron microscope at temperatures between 8 and 300°K. The formation and growth of interstitial clusters was observed during irradiation at 8 to 165°K and of vacancy clusters at 50 to 165°K, i.e. at temperatures well below annealing stage III (~170°K in lead). The observation of vacancy cluster growth is interpreted as evidence for preferential absorption of interstitials at sample surfaces. By a combination of above- and sub-threshold irradiations and in situ annealing treatments, it could be shown that the point-defect motion responsible for cluster formation below Stage III is of radiation-induced nature. The importance of radiation-induced diffusion for the low-temperature irradiation and the annealing behaviour of lead and gold is discussed. Various mechanisms which may be responsible for radiation-induced defect migration and its main characteristics are considered. (auth)

# Other Materials

*Refer also to abstracts 20171–20174, 20196, 20250, 20262–20264, 20430, 20431, and 20465.*

**20468** (AD-780912) FAILURE MECHANISMS IN IRRADIATED PLASTIC INTEGRATED CIRCUITS. Final Report, 1 July–31 December 1973. Taylor, S. A. (Martin Marietta Aerospace, Orlando, Fla. (USA)). Apr 1974. Contract DAAB07-73-C-0313. 140p. (OR-12957; ECOM-0313-F-73). NTIS $4.75.

The program was devised to evaluate the performance of plastic integrated circuits in various types of radiation environments. Two different test parts were employed. These parts were selected to be representative of broad semiconductor processing technologies. The bipolar process technology was represented by

741 operational amplifier. The complementary metal-oxide-silicon (CMOS) process was represented by the 4028 binary-to-decimal decoder. (GRA)

**20469** (AD-784792) SUMMARY REPORT ON MAGNETIC BUBBLE MATERIAL RADIATION HARDNESS STUDY. Lowe, L. F.; Turner, C. D.; Hyatt, J. R. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass. (USA)). 12 Jul 1974. 13p. (AFCRL-PMSRP-597). NTIS $3.00.

Several magnetic bubble material samples were exposed to fission neutrons and $^{60}$Co gamma rays in order to assess their radiation sensitivity. No changes in magnetic properties were observed in any sample up to $4 \times 10^{14}$ n/cm$^2$ and $10^8$ to $10^9$ rad (Si) $^{60}$Co. A table summarizes the results and also gives other results on other samples which were irradiated at AFCRL and evaluated elsewhere. The in-house measurements consisted of coercivity, magnetization, wall energy, and characteristic length. An appendix gives a detailed data analysis of the in-house experimental results on three samples. The remainder of this report consists of a brief summary of the experimental measurements made at AFCRL and also the details of the radiation exposures. (GRA)

**20470** (AED-CONF-74-328-003) ELECTRONIC ABSORPTION NEAR THE BAND EDGE IN NEUTRON IRRADIATED GERMANIUM. Newman, R. C.; Totterdell, D. H. J. (Reading Univ. (UK). J. J. Thomson Physical Lab.). 1974. 10p. (CONF-740729-9). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

Neutron irradiation of Ge at room temperature produces defects giving rise to near edge absorption and the samples become progressively more p-type. Samples initially doped with As or Sb donors ($6 \times 10^{18}$ cm$^{-3}$) show an absorption band at 2.78 $\mu$m provided they remain n-type. These and previous observations are discussed in relation to the possible existence of divacancies in Ge. (auth)

**20471** (AED-CONF-74-328-006) VACANCY MOTION IN ION IMPLANTED SILICON. Dennis, J. R.; Woodward, G. K.; Hale, E. B. (Missouri Univ., Rolla (USA). Graduate Center for Materials Research). 1974. 8p. (CONF-740729-10). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

The formation of amorphous silicon produced by the ion implantation of crystalline silicon was investigated. Undoped silicon was implanted with $N^+$, $Ar^+$ or $Kr^+$ ions at 20 keV at a dose rate of 0.35 $\mu$ amps/cm$^2$. The implant temperature ranged from 80 K up to 700 K. The amount of amorphous material formed was determined by ESR measurements. The critical dose for formation of a continuous amorphous layer was determined as a function of temperature. At low (< 100 K) temperature, this dose is independent of temperature and is 2.5, 1.8 and $1.4 \times 10^{14}$ ions/cm$^2$ for $N^+$, $Ar^+$ and $Kr^+$ respectively. At high temperatures the critical dose has a strong temperature dependence and asymptotically approaches a temperature limit, T-infinite = 400 K, 540 K, and 725 K for $N^+$, $Ar^+$ and $Kr^+$ respectively. The migration energy of the defect for low energy, heavy ion implants suggests that the important diffusing defect is the double negative charge state of the vacancy. (auth)

**20472** (AED-CONF-74-328-010) PHASE-TRANSITION-LIKE ANNEALING BEHAVIOUR OF HEAVILY IMPLANTED GaP. Shimada, T.; Shiraki, Y.; Kato, Y.; Komatsubara, K. F. (Hitachi Ltd., Kokubunji, Tokyo (Japan). Central Research Lab.). 1974. 8p. (CONF-740729-4). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

A structural phase-transition-like annealing behavior from a non-crystalline (disordered) state to a different non-crystalline (amorphous) state was found in heavily implanted GaP. The ion dose dependence and the annealing behavior of the atomic structure of GaP implanted with 200-keV $N^+$ ions were studied by using electron diffraction, backscattering, and volume change measurements. The electronic structure was also investigated by using optical absorption, conductivity and ESR measurements. The implanted layer gradually loses the crystalline order with increase in dose, and changes into the disordered state at around $2 \times 10^{15}$ cm$^{-2}$. The annealing behavior of the sample implanted with $N^+$ ions of $1 \times 10^{16}$ cm$^{-2}$ (in the disordered state) is quite different from that of $1 \times 10^{15}$ cm$^{-2}$ (still in the crystalline state). The former shows an abrupt change of atomic structure from the disordered state to the amorphous state at around 400°C. The changes in the optical and electrical properties of heavily implanted GaP correlate with the change of the atomic structure. The optical absorption coefficients abruptly decrease and the electrical conductivities become very high after annealing at 400°C. (auth)

**20473** (AED-CONF-74-328-013) A NEW TECHNIQUE FOR DEFECT SPECTROSCOPY IN SEMICONDUCTORS: APPLICATION TO 1-MeV ELECTRON IRRADIATED n-GaAs. Lang, D. V.; Kimerling, L. C. (Bell Telephone Labs., Inc., Murray Hill, N. J. (USA)). 1974. 11p. (CONF-740729-8). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

A new technique for defect spectroscopy in semiconductors is presented. This is a high-frequency junction capacitance transient thermal scanning method which is able to display the spectrum of defect levels near a p-n junction or Schottky barrier as positive and negative peaks on a flat baseline as a function of temperature. It is sensitive, rapid, and easy to analyze. The sign of the peak indicates whether the level is near the conduction or valence band, the height of the peak is proportional to the trap concentration, and the position in temperature of the peak is uniquely determined by the thermal emission properties of the level. In addition one can measure the activation energy for emission, concentration profile, and electron and hole capture cross sections for each level. The technique is illustrated by its application to room temperature 1 MeV electron irradiated n-GaAs. Six defect levels are observed to enter linearly with electron fluence with two additional defect levels present in the as grown material. The activation energy for emission and introduction rate is measured for each level. (auth)

**20474** (AED-CONF-74-328-019) DISTRIBUTION OF SECONDARY DEFECTS IN BORON IMPLANTED SILICON. Lecrosnier, D. P.; Pelous, G. P.; Henoc, P. (Centre National de la Recherche Scientifique, 54-Villers-les-Nancy (France). Centre de Cinetique Physique et Chimique). 1974. 8p. (CONF-740729-2). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

Transmission electron microscopy observations were performed on 1-MeV boron implanted silicon. The use of such a high energy gives a range of 1.86 $\mu$ for boron atoms and provides samples with well-buried layers. By anodic oxidation and HF stripping, layers of controlled thickness were removed before the samples were back-thinned to about 1,000 A for microscopy observation. This procedure allows observation of the density and the nature of defects versus depth. The samples were implanted at room temperature with doses of $10^{15}$ or $10^{14}$ ions/cm$^2$ in a direction 7 deg. off the ⟨111⟩ axis. Annealing was performed at 1,000°C during 30 minutes in a nitrogen atmosphere. No defects were found in the region crossed through by the ions. In the region from 1.6 $\mu$ to 2 $\mu$ perfect dislocation loops are the predominant defect detected. These dislocations lie on the ⟨111⟩ plane parallel to the surface. In all cases, their nature is shown to be vacancy type with a Burgers vector of a/2 (1 anti 10). The results indicate a long range interaction between primary defects and impurities. (GE)

**20475** (AED-CONF-74-328-020) LOW-TEMPERATURE IRRADIATION AND ANNEALING OF n-TYPE CADMIUM-TELLURIDE. Caillot, M. (Ecole Normale Superieure, 75-Paris (France). Groupe de Physique des Solides). 1974. 12p. (CONF-740729-11). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R Germany (22 Jul 1974).

With abstract. Available from ZAED.

Electron irradiation of n-type compensated or uncompensated CdTe were performed at 1.5 MeV and liquid helium temperature. In compensated samples, the conductivity measured at 20 K decreases linearly with the flux whereas the one measured at 4.2 K decreases exponentially with the dose. This latter effect is interpreted by a hopping conduction whose activation energy increases linearly with the dose of irradiation. The behavior of the conductivity during isochronal annealings allows separation of the effect due to traps present before irradiation from the one due to defects produced by irradiation. Extrinsic photoconductivity and conductivity experiments show an annealing stage beginning at 135 K in all samples. From photoconductivity spectra, the energy level of the defect which anneals is determined as $E_v + 0.45$ eV. Isothermal annealings show at first the kinetics is of the first order. (auth)

**20476** (AED-CONF-74-328-021) INTRODUCTION AND ANNEALING OF DEFECTS IN GaP UPON ELECTRON IRRADIATION. Brailovskii, E. Yu.; Konozenko, I. D.; Makarenko, V. G.;

Manzhara, V. S.; Tartachnik, V. P. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1974. 8p. (CONF-740729-6). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract. Available from ZAED.

Introduction and annealing of point radiation defects in n- and p-type GaP crystals upon electron irradiation were investigated by electrical and photoluminescence methods. A monotonous decrease of conductivity, carrier concentration, and photoluminescence intensity as the result of irradiation at room temperature occurs. The introduced defects have mainly acceptor properties. From extrapolation of carrier removal rate dependence versus the electron energy in n-type GaP, the value of threshold energy of (330 ± 30) keV is obtained. In n-GaP predominant annealing of sigma took place in the first order kinetic stage centered at 140-190°C. Besides this stage the ones at 250-300°C and 500°C are well noticeable. In p-type GaP the annealing stage occurs at 250-300°C and after annealing temperature of 400°C there is a considerable unannealed fraction. The bound exciton lines disappear in photoluminescence spectra at a lower radiation dose than acceptor-donor pair emission. The data on photoluminescence spectra recovery is given. The probable nature of radiation defects is discussed. (auth)

**20477** (AED-CONF-74-328-024) EPR IDENTIFICATION OF ZINC VACANCY-ZINC INTERSTITIAL CLOSE-PAIRS IN IRRADIATED ZnSe. Watkins, G. D. (General Electric Co., Schenectady, N. Y. (USA). Research and Development Center). 1974. 13p. (CONF-740729-5). INIS.

From meeting on application of lattice defects in semi-conductors; Freiburg, F. R. Germany (22 Jul 1974).

With abstract.

Irradiation of ZnSe at 20.4 K with 1.5-MeV electrons produces four distinct EPR spectra which are identified as arising from simple zinc vacancy–zinc interstitial close pairs of different microscopic configuration. Correlation of defect alignment with incident electron beam direction confirms the identification. Uniaxial stress alignment studies are also described. Specific microscopic models are proposed for each. Isolated zinc vacancies are also produced but with zero initial production rate, suggesting that their production is a two-step process, the first being the formation of close pairs. (auth)

**20478** (AGC-871-2209) RADIATION RESISTANCE OF SILICONE LAMINATE TUBING. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 21 Nov 1963. 4p. Dep. NTIS $4.00.

The effect of radiation on silicone-glass laminate tubing was based on the damage limits of silicone-glass. Silicone-glass laminates have withstood $10^{11}$ ergs/gram exposure of gamma radiation without adverse affects. (auth)

**20479** (CEA-R-4595) TRANSMISSION ELECTRON MICROSCOPE STUDY OF DEFECTS IN ION IMPLANTED SILICON AND OF THEIR ANNEALING. Truche, R. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. d'Electronique et de Technologie de l'Informatique). Oct 1974. 99p. (In French). Dep. NTIS (US Sales Only) $8.00.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble, France.

Silicon specimens have been implanted at room temperature with boron (30 keV, $10^{16}$ ions/cm$^2$), phosphorus (30 kev, $10^{16}$ ions/cm$^2$) or arsenic (50 to 140 keV, doses between $10^{14}$ and $7.10^{16}$ ions/cm$^2$). They are annealed at temperatures from 500 to 1000°C. When an amorphous silicon layer is created, it recrystallizes at 650°C. At higher temperature, microtwin crystals and vacancy loops are observed in the recrystallized layer while interstitial loops appear deeper within the specimen. After annealing at 850 or 1000°C respectively for P or As implanted specimens, the interstitial loops disappear. Below the critical irradiation dose required to form an amorphous layer many interstitial loops persist up to annealing temperatures of 950°C. Attempts have been made to correlate these results with measurements of sheet resistivity and current gain amplification in implanted transistors. Ion implantation forms a surface layer containing a monocrystalline phase and a high implanted ion concentration. (auth)

**20480** (HEDL-TME-72-98) FAST REACTOR FLUX-INDUCED CREEP IN 20% COLD WORKED TYPE 316 STAINLESS STEEL. Gilbert, E. R.; Kaulitz, D. C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1972. Contract AT (45-1)-2170. 37p. Dep. NTIS $5.00.

An instrumented in-reactor creep test was conducted on the Fast Test Reactor prototypic 20% cold-worked Type 316 stainless steel cladding. The test was conducted at 849°F in a fast neutron flux (E > 0.1 MeV) of $1.76 \times 10^{15}$ nv. Flux-induced creep was observed in the form of transient and steady-state deformations. The creep results could be described by the following equation: $\bar{\epsilon} = [9.7 \times 10^{-28} \{1 - \exp(-\bar{E}\phi t/3.86 \times 10^{20})\} + 1.5 \times 10^{-34} t] \bar{E}\phi\bar{\sigma}^2$ where $\bar{\epsilon}$ is fractional effective strain, $\bar{\sigma}$ is effective stress in psi, $\bar{E}$ is mean neutron energy in MeV, $\phi$ is total neutron flux (E > $10^{-10}$ MeV) in nv and t is time is seconds. Since strain was continuously monitored only at one stress level, it is not possible to determine distinct stress dependencies for transient and steady-state creep. However, if the steady-state strain were linear in applied stress, then the transient strain is nonlinear in stress and the creep strain can be described by the equation: $\bar{\epsilon} = 5.2 \times 10^{-24} \bar{E}\phi (\exp 5.8 \times 10^{-4}\bar{\sigma}) [1 - \exp(-\bar{E}\phi t/3.86 \times 10^{20})] + 3.1 \times 10^{-30}\bar{E}\phi t\bar{\sigma}$. (auth)

**20481** (JAERI-M-5800) EFFECTS IN ELECTRON BOMBARDMENT OF LITHIUM FLUORIDE SINGLE CRYSTALS AT HIGH TEMPERATURES. I. The Depth Distribution of F Center Density. 2. The Formation of Colloidal Centers. Kubo, K. (Japan Atomic Energy Research Inst., Tokyo). Jul 1974. 14p. Dep. NTIS (US Sales Only).

The peak height of F absorption band vs. depth from the surface has been measured in LiF crystal bombarded by electrons. The depth distribution of F center density is characterized by multiple scattering of electrons in the crystal, and it agrees primarily with the depth distribution of electron energy loss calculated with the Spencer theory. With increase of the bombarding electron dosage, the F center density curve deviates from the theoretical energy loss curve due to the saturation of F center density. An additional shoulder appears beyond the electron range, which is possibly caused by the secondary photons emitted during penetration of the electrons in LiF. The colloidal centers formed in electron-bombarded pure LiF crystals have been studied in heat-treatment up to 700°C. The optical absorption bands induced were the same as those by neutron-irradiation, except lack of the 550 nm (S) band; which indicates that the neutron effect in LiF amounts nearly to the ionization with localized heating. Consistent assignment of the absorption centers may be as follows: The 500 nm (E) band arises from an aggregate color center. The 430 and 480 nm bands are due to the Mie's scattering of light by metallic Li colloids. The bands at about 270 and 370 nm are caused by the resonant oscillation of plasma electrons in the metallic Li colloids, shaped in circular cylinder and sphere, respectively. The broad band at 300 nm, formed finally at temperatures above 500°C, results from the quasimetallic zones left after the Li atoms have diffused out from the metallic colloids. (auth)

**20482** (JAPFNR-172) STUDY ON FAST BREEDER REACTOR INSTRUMENTATION. II. Gamma Irradiation Tests of Wire and Cable Insulations and Electronic Component Materials. Kakuta, T.; Wakayama, N.; Kawakami, T. (Japan Atomic Energy Research Inst., Tokyo). Aug 1974. 97p. Dep. NTIS (US Sales Only) $8.00.

For Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan.

Insulation materials of cables and cable connectors, which are used in fast breeder reactor instrumentation and $\alpha$-$\gamma$ hot caves, were tested by the $^{60}$Co $\gamma$-ray source facility in JAERI. The tests were performed under the environment condition of room temperature, air and nitrogen gas, and in heated air (100 and 150°C). The maximum radiation dose of $\gamma$-ray was $6 \times 10^8$R. It was found that polyimide, polyamide-imido, ethylene-propyren rubber and cross-linked polyethylene are highly resistant to radiation. The data and the discussion obtained here are available for use in selection of the materials which are to be used in radiation environments. (auth)

**20483** (JUL-1082-RW) ON THE INFLUENCE OF THE METHOD OF MEASUREMENT ON THE OPTICAL ANISOTROPY FACTOR OPTAF OF PYROCARBON. Wasmund, H.; Koizlik, K.; Taeuber, K.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jul 1974. 31p. (In German). INIS.

18 figs.; 5 tabs.; 34 refs.

The development and installation of an automatic microscope photometer for the measurement of the optical anisotropy factor OPTAF on the pyrocarbon coatings of fuel particles are described. After a short representation of the physical basis of the procedure the new microscope photometer is introduced. First measurements for the adaptation of the new instrument to the one used so far are discussed. By these measurements the influence of the instrument on the value of OPTAF in the case of some special ways of measuring are explained and the appearance of an apparent anisotropy is interpreted. (auth)

**20484** (JUL-1096-RW) METHOD FOR THE DETERMINATION OF THE HEAT CONDUCTIVITY OF NEUTRON-IRRADIATED GRAPHITES AT TEMPERATURES BETWEEN 50 AND 1000°C.

Binkele, L. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Aug 1974. 114p. (In German). Dep. NTIS (US Sales Only) $8.75.

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

A measurement method was developed which gives a rapid and relatively accurate out-of-pile measurement of the heat conductivity on small neutron-irradiated graphite cylinders in the temperature range from 50 to 1000°C. The method represents a development of the Kohlrausch method except that the simple relation between the heat conductivity and directly measurable parameters characteristic of this method is eliminated. These relations were obtained by apparatus procedures and by a simplified treatment of the complicated heat conductivity equations. The measurement procedure is explained in detail and the systematic errors in the method are examined. (JSR)

**20485** (ORNL-tr-2882) OPTICAL METHOD FOR MEASURING THE ORIENTING ANISOTROPY OF PYROCARBON SHEATH LAMINATED COATED NUCLEAR FUEL PARTICLES. Koizlik, K.; Gruebmeier, H. B. Translated by R. G. Mansfield from Leitz-Mitt. Wiss. Tech.; 6: No. 4, 121-126(1974). 11p. Dep. NTIS $4.00.

Procedures for evaluating pyrocarbon orienting anisotropy and its change with neutron irradiation are described. Discussions are included on measurement of optical anisotropy factors, orienting anisotropy of pyrocarbon coatings, and applications of optical anisotropy measuring methods. (JRD)

**20486** (RN-S-0234) FINAL TEST REPORT FOR RADIATION EFFECTS TEST ON PYLE ZZM-W-2416-1850 CONNECTOR. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1965. 11p. Dep. NTIS $4.00.

A Pyle Model ZZM-W-2416-1850 hermetically sealed connector was irradiated at GTR to an integrated exposure of $7.18 \times 10^{16}$ neutrons/cm$^2$ (E > 0.9 MeV) and $2.36 \times 10^{11}$ ergs/gm (C) gamma radiation. The Buna N hermetic seal failed at an integrated exposure of $2.0 \times 10^{16}$ neutrons/cm$^2$ (E > 0.9 MeV); however, the pin-to-pin electrical insulation never decreased below 8 megohms. (auth)

**20487** (RN-S-0420) FINAL REPORT ON GTR-18 TEST OF BEARING CAGE MATERIALS. Dessau, P. P.; Weleff, W. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1967. 15p. Dep. NTIS $4.00.

Results of Test 37/R106 to determine the radiation effects on bearing cage materials in a liquid-hydrogen environment are presented. Materials tested included four polyimide-based composites, a nickel compact impregnated with molybdenum disulfide, a polybenzimidazole glass reinforcement, a CDJ graphite, and a proprietary composite. Specimens were irradiated in liquid hydrogen and tested at room temperature. The gamma dose was $7 \times 10^{10}$ ergs/gm(C). Data were obtained on tensile, compressive, and flexural strengths for control and irradiated specimens. (auth)

**20488** (RN-S-0549) FABRICATION AND PROPERTIES OF THE FIBROUS REINFORCED GRAPHITE COMPOSITE, AGCarb-101. Davis, H. O.; Kotfila, R. J.; Schleicher, W. J. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Mar 1970. 186p. Dep. NTIS $12.50.

The fabrication characteristics for the production of a fibrous-graphite-reinforced composite, AGCarb-101, are described. Plates and cones were fabricated to determine the following physical and mechanical properties: tensile strength in three directions, compression strength, flexure strength, interlaminar shear strength, fatigue strength, fracture toughness, dynamic modulus, damping decrement, porosity, permeability, hardness, electrical resistivity, thermal expansion, and thermal conductivity. The data obtained from the plates are to be used as baseline data for design purposes. The data from the cones were to be used to determine the effect of the configuration on the properties; however, defects (wrinkles) in the cones prevented correlation of data from plates and cones. Additional work is required to improve the fabrication characteristics of the cones. (auth)

**20489** (SAND-74-0235) EQUILIBRIUM GAS COMPOSITIONS OF METAL-CARBON-CHLORINE-HYDROGEN SYSTEMS. Lieberman, M. L.; Wurtz, J. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 45p. Dep. NTIS $5.50.

Thermodynamic calculations of equilibrium gas compositions were performed for M-C-Cl-H systems, where M represents Nb, W, Ti, and Zr, for single- and multiphase conditions. The effects of temperature, pressure, atomic ratios, and number of phases on the concentrations of the various species were evaluated for each system. (auth)

**20490** (TID/SNA-637) RADIATION EFFECTS ON LUBRICANTS FOR NERVA APPLICATION. French, W. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Aug 1970. 39p. Dep NTIS $5.00.

A summary is presented of the radiation effects testing portion of NERVA lubrication tests, and radiation effects testing of solid-film lubricants. The following conclusions are: Lubrication by the laminar solids $MoS_2$ and $MoSe_2$ is not appreciably altered by high-level radiation. An inorganic or ceramic binder can be used with the laminar solid, to form a solid film, but not an organic resin binder which will suffer radiation damage. (50 references, 17 tables) (DLC)

**20491** (WANL-TME-1637) IRRADIATION EFFECTS ON THE MECHANICAL AND ELECTRICAL PROPERTIES OF P-03, H4LM, AND 780-T GRAPHITES. Shogan, R. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1967. 63p. Dep. NTIS $6.25.

Three grades of graphite, H4LM (with and without silica impregnation), 780-T, and P-03, were irradiated at 140°R in liquid nitrogen ($LN_2$) at the Ground Test Reactor (GTR). A neutron dose of $1.7 \times 10^{17}$ to $4.5 \times 10^{17}$ nvt (E > 1 MeV) and a gamma dose of $9 \times 10^{10}$ to $1.5 \times 10^{11}$ ergs/gm(C) were obtained. Room temperature tests were made on irradiated and unirradiated specimens for electrical resistivity, tensile strength, and compressive strength after anneals at temperatures up to 1200°F. Some electrical resistivity data at higher temperatures are also reported. The H4LM grade, with and without $SiO_2$ impregnation, was affected most by the irradiation. Impregnated H4LM in the "with grain" (W. G.) direction showed increases of 114% in electrical resistivity and 39% in compressive strength. Unimpregnated H4LM in the "across grain" (A. G.) direction showed a maximum tensile strength increase of 56%. The least affected was the P-03 grade with a 31% increase in electrical resistivity and a 15% increase in compressive strength. Impregnated H4LM, W. G., showed only a 17% increase in tensile strength. The other materials showed changes lying between these values. The maximum changes in resistivity were found at room temperature before annealing, while the change in mechanical properties generally increased to a maximum with an anneal between 200 and 400°F. The effects of the irradiation were nearly removed with annealing temperatures up to 500 to 700°F where the properties reached a somewhat steady value slightly higher than those of the control (unirradiated) specimens. (38 fig, 8 tables) (auth)

**20492** THERMOLUMINESCENCE OF QUARTZ INCLUDED IN GARNET-BEARING BIOTITE ANDESITE FROM NIJO HILL, NARA PREFECTURE. Inagaki, H. Chigaku Kenkyu; 24: No. 1-6, 31-37(Dec 1973). (In Japanese).

Thermoluminescence before and after gamma irradiation and coloring effect by gamma irradiation were investigated on quartz included in garnet-bearing biotite andesite from Nijo hill. The nature of the quartz resembles that of high-temperature quartz from lava or tuff in natural thermoluminescence, but the quartz is quite different from high quartz from volcanic rock in the height (intensity) of C glow peak (at 235 ~ 300°C) and in coloring effect after gamma irradiation. So, it is concluded that the quartz is presumably not magmatic origin, but captured by the andesite magma from other rock formed at a relatively low temperature. The present experimental data suggest that the nature of the quartz may be related to the heated effect by the magma. (auth)

**20493** CHARGE AND POTENTIAL DISTRIBUTION IN DIELECTRIC LAYERS OF MOS STRUCTURES UNDER IONIZATION. Vinetskii, V. L.; Chaika, G. E.; Shevchenko, E. S. (Inst. of Physics, Kiev). Phys. Status Solidi (a); 26: No. 2, 743-752 (16 Dec 1974).

Parameter changes of metal/oxide/semiconductor (MOS) structures under ionizing radiation are caused by the buildup of a positive charge in the oxide which value and topology depend in a complex way on the applied voltage. A proposed simple model and calculation method for the potential distribution in MOS structure, with arbitrary value and polarity of the applied voltage and based on the solution of the Poisson and kinetic equations system with account of boundary conditions changing with the applied voltage, allow to determine the topology and value of the buildup charge and the resulting shift of the MOS characteristics in good agreement with experiments. (auth)

**20494** CHARACTERISTICS OF BREMSSTRAHLUNG REFLECTED BY INHOMOGENEOUS MEDIA. Golikov, E. G.; Sukhanova, K. A.; Bulatov, B. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 61-65(1974). (In Russian).

The results of the experimental study of the energy and angular distribution of quanta, scattered by two-component powdered

mixtures and liquids in thin-shelled vessels during their irradiation with betatron bremsstrahlung were reported. The study was made in order to evaluate the possibilities of the method for the measurement of the concentration of the basic elements in the inhomogeneous media from the spectral-angular characteristics of the reflected bremsstrahlung. The results showed that the concentration of the basic elements can be determined by measurement of the intensity of the reflected bremsstrahlung in the energy range from 0.1 to 0.55 MeV. (JSR)

**20495** ENERGY DETERMINATION FROM ELECTRON RANGE IN ALKALI-HALIDE CRYSTALS. Lubane, M. S.; Baltmugur, K. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 31-35(1974). (In Russian).

The coloration of alkali-halide crystals was used to determine electron energies in the region under 10 MeV. The coloration depth in a crystal (the visual range) was measured on a lighted transparent ruler and an empirical relation was used to determine the extrapolated range. The most sharp edge of coloration was obtained in KBr crystals. The electron energy was calculated from a semi-empirical relation between the extrapolated range of electrons and their energy. (auth)

**20496** STRUCTURE OF URANIUM TRIBROMIDE BY NEUTRON DIFFRACTION PROFILE ANALYSIS. Levy, J. H.; Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Less-Common Metals; 39: No. 2, 265-270(Feb 1975).

A neutron powder-diffraction analysis of uranium tribromide has been carried out with the profile-fitting technique and has confirmed that $UBr_3$ is of the $UCl_3$ structure type. The final value of $R = \Sigma_i(|I_{oi} - I_{ci}|)/\Sigma_i I_{oi}$ was 0.10, where $I_{oi}$ is one of the 395 background-corrected measured intensities in the pattern. $UBr_3$ is hexagonal, space group $P6_3/m(C_{6h}^2)$ with $a = 7.942(2)$ and $c = 4.441(2)$ Å and $Z = 2$. The uranium atoms lie in positions 2(d), $\pm(\frac{2}{3}, \frac{1}{3}, \frac{1}{4})$ and the bromine atoms in positions 6(h), $\pm(x, y, \frac{1}{4}; \bar{y}, x-y, \frac{1}{4}; y-x, \bar{x}, \frac{1}{4})$ with $x = 0.2996(4)$ and $z = 0.3859(4)$. The configuration around the uranium atom is a tricapped trigonal prism, with U–Br (3 x) = 3.145(3) Å (uranium to capping bromine atom) and U–Br (6 x) = 3.062(2) Å (uranium to bromine at corner of trigonal prism). (auth)

**20497** TENTATIVE IDENTIFICATION BY ESR OF A $CSO_3^{3-}$ IMPURITY RADICAL IN IRRADIATED SINGLE-CRYSTAL. Marshall, R. L.; Ohlsen, W. D.; Marshall, S. A.; Serway, R. A. (Univ. of Utah, Salt Lake City). J. Magn. Resonance; 15: No. 1, 89-97(Jul 1974).

A paramagnetic defect tentatively identified as $CSO_3^{3-}$ was studied in irradiated natural calcite. Identification was based on chemical considerations, the fact that more than 99% of sulfur nuclei have spin zero, and upon a g value calculation which involves no adjustment of model parameters to fit the experimental data. The center is produced by room-temperature electron, γ, or x-ray irradiation but may be seen by ESR only below about 190°K. The ESR spectrum shows no hyperfine structure and consists of contributions from six inequivalent sites. Pairs of these sites are nearly equivalent and the g-tensor principal axes are nearly such that one is along a normal C-O direction, a second is perpendicular to a normal Ca-O-Ca plane, and the third is perpendicular to the other two. The associated g-values are 2.001, 2.063, and 2.008, respectively. (auth)

**20498** CRYSTAL STRUCTURE OF URANIUM TETRABROMIDE BY X-RAY AND NEUTRON DIFFRACTION. Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Acta Crystallogr., Sect. B; 30: No. 11, 2664-2667(15 Nov 1974).

Uranium tetrabromide, $UBr_4$, is monoclinic, space group C2/m ($C_{2h}^3$, No. 12), with $a = 10.92$ (2), $b = 8.69$ (3), $c = 7.05$ (1) Å and $\beta = 93.9$ (1)°, $Z = 4$, $D_m = 5.35$, $D_x = 5.55$ g cm$^{-3}$. The crystal structure was solved with the aid of x-ray and neutron powder diffraction data, and refined with the neutron powder data by the profile-fitting technique. The final R was 0.15 for 274 measured intensities. The configuration around the uranium atom is a pentagonal bipyramid of bromine atoms, and the bipyramids are linked into infinite two-dimensional sheets by double bromine-bridging of the uranium atoms. There are only van der Waals attractions between sheets. The interatomic distances and angles within and between sheets are normal. $UBr_4$ appears to be the only actinide halide $MX_n$ (where n is 3 to 6) which has apentagonal bipyramidal configuration around uranium, except for β-$UF_5$ and $PaCl_5$. It is apparently the only actinide tetrahalide studied so far in which the coordination number is less than eight. (auth)

**20499** STRUCTURE OF URANIUM(III) TRICHLORIDE BY NEUTRON-DIFFRACTION PROFILE ANALYSIS. Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Acta Crystallogr., Sect. B; 30: No. 12, 2803-2805(15 Dec 1974).

A precise neutron-diffraction powder study of $UCl_3$ was carried out which confirmed the structure proposed in an early x-ray powder study of Zachariasen. $UCl_3$ is hexagonal with space group $P6_3/m$ ($C_{6h}^2$) and $a = 7.443$, $c = 4.321$ Å, and $Z = 2$. A least-squares analysis with the profile-fitting technique gave $R = \Sigma_i(|I_{oi} - I_{ci}|)/\Sigma I_{oi} = 0.077$, where $I_i$ is a background-corrected intensity at a point i on the pattern. The uranium atoms are in positions 2(d), $\pm(\frac{2}{3}, \frac{1}{3}, \frac{1}{4})$ and the six chlorine atoms in 6(h), $\pm(x, y, \frac{1}{4}; \bar{y}, x-y, \frac{1}{4}; y-x, \bar{x}, \frac{1}{4})$. Measured parameters were $x_{Cl} = 0.3009$ (4) and $y_{Cl} = 0.3858$ (4). The uranium coordination polyhedron is a tricapped trigonal prism with U–Cl (6x) = 2.931 (2) Å and U–Cl (3x) = 2.938 (3) Å. (auth)

**20500** EXTENDED BASAL PLANE SHEAR IN PYROLYTIC GRAPHITE AT 3035 K. Thompson, A. W. (Rockwell International, Thousands Oaks, CA). J. Mater. Sci.; 9: No. 11, 1900-1902(Nov 1974).

Pyrolytic graphite in the as-deposited state has a structure of basal plane layers which are parallel to but randomly orientated from neighboring layers. When heated above 2800°K, or heated and deformed parallel to the deposition plane, this structure, "graphitizes." The combined processes have been likened to straightening a stack of wrinkled sheets. For deformation at temperatures near 3000°K, the dewrinkling process occupies about the first 10% strain. The basal planes are relatively well aligned with the tensile axis. It would be of interest, however, to examine the process of shear on the basal planes after the dewrinkling is complete. The present communication describes a technique for doing so, and briefly presents results of tests using the technique. (auth)

**20501** BEHAVIOUR OF PYROLYTIC CARBONS IRRADIATED UNDER MECHANICAL RESTRAINT. Kaae, J. L. (Gulf General Atomic Co., San Diego, CA). Carbon; 12: No. 5, 577-590(Oct 1974).

The behavior of isotropic pyrolytic carbons irradiated free from stress is compared with that of the same carbons when the irradiation-induced shrinkage is prevented by an unyielding substrate. Failure of the restrained specimens cannot be predicted from the irradiation-induced dimensional changes of the unrestrained specimens, and fracture strengths do not appear to decrease during irradiation in either a restrained or an unrestrained state. However, restraint and the resulting irradiation-induced creep produce an increase in the preferred orientation of the carbon crystallites. This increase in preferred orientation results in increased irradiation-induced dimensional change rates which can explain the discrepancies in the irradiation behavior of the restrained and unrestrained carbons. (auth)

**20502** DSC STUDY OF THE EFFECT OF IRRADIATION UPON THE GLASS TRANSITION TEMPERATURE ($T_g$) OF POLYETHYLENE. Simon, J.; Beatty, C. L.; Karasz, F. E. (Univ. of Massachusetts, Amherst). J. Therm. Anal.; 7: No. 1, 187-190 (Feb 1975).

The glass transition of an irradiated, ultra-high molecular weight, linear polyethylene was investigated by means of the Perkin–Elmer DSC-2 differential scanning calorimeter. The experimental specific heat data were compared with those of the nonirradiated sample, obtained by DSC and adiabatic calorimetry. (auth)

**20503** INFLUENCE OF CHANNELLING EFFECT ON FORMATION RATE AND SPATIAL DISTRIBUTION OF F-CENTERS IN NaCl SINGLE CRYSTALS UNDER IRRADIATION WITH 100 TO 500 keV PROTONS AND 5.5 MeV α PARTICLES. Tolpygo, S. K.; Shipatov, E. T. (Donetsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 9, 1438-1441(Sep 1974). (In Russian).

Curves of F center accumulation and distribution along the depth of NaCl single crystals were studied under irradiation with 100–500 keV protons when the incident particles move along the single crystal axis ⟨100⟩ and with a 5.5-MeV α particles. When the irradiation does exceed $5 \times 10^4$ particles/cm$^2$, one may observe saturation of the coloration density and uniform distribution of F-centers to the single crystal depth equal to the particle mean path. The observed effects of an increase in the coloration depth (approximately 1.5-fold), in the value of optical density with saturation (1.2–1.3-fold) and in the rate of optical density accumulation for the proton irradiation oriented along the axis ⟨100⟩ are explained by peculiarities in formation of F-centers by channelled particles. (auth)

**20504** METHOD FOR PRODUCING REFRACTORY CARBIDE COATINGS ON GRAPHITE. Gust, W. H. (to Energy Research and Development Administration). US Patent 3,860,437. 14 Jan 1975. Filed date 10 Mar 1959. 6p.

The process for coating graphite with an adherent, continuous layer of metallic carbide comprises the steps of disposing a quantity of a refractory carbide-forming metal to be carburized in a contiguous, generally spaced relation with a smooth graphite surface, said spacing being sufficient to permit flow of a gas between said surface and said metal, enclosing said assembly with a nonreacting gaseous atmosphere containing methane, heating said assembly to a temperature above the decomposition point of said methane and slightly above the softening point of said metal, whereby a quantity of said methane undergoes pyrolysis and deposits carbon on said graphite and said metallic surfaces, and quickly raising the temperature of said assembly to a point at which carburization occurs. (auth)

**20505** METHOD FOR PRODUCING REFRACTORY CARBIDE COATINGS ON GRAPHITE. Gust, W. H.; Heckman, R. A.; Voreck, W. E. Jr. (to Energy Research and Development Administration). US Patent 3,860,445. 14 Jan 1975. Filed date 10 Mar 1959. 6p.

A process for coating graphite with an adherent, continuous layer of metallic carbide comprises the steps of disposing a quantity of Mo, Nb, or Zr in contiguous gas permeable relation with a first piece of graphite, superimposing a graphite clamping means of identical surface shape over said metal and said graphite piece, adjusting said graphite clamping means and said graphite piece to maintain a tolerance of about 1 mil between said metal and at least one contiguous graphite surface degassing said assembly, enclosing said graphite-metal interfaces within a nonreactive gaseous atmosphere, quickly heating said assembly to a temperature at which said metal carburizes, cooling said assembly and mechanically separating and removing said graphite clamping means from said adherent coating. (Official Gazette)

**20506** CALCULATION OF THE ELASTIC CONSTANT $C_{33}$ OF GRAPHITE CRYSTAL AS A FUNCTION OF TEMPERATURE. Kelly, B. T. (UKAEA Reactor Group, Springfields, Eng.). Carbon; 12: No. 5, 535-541(Oct 1974).

A calculation is presented of the elastic constant $C_{33}$ of a graphite crystal as a function of temperature up to 2500°K, taking into account the anharmonic contribution and the changes in interlayer interactions due to the large lattice thermal expansion. Parametric variations in the theory show that the anharmonic contribution to $C_{33}$ depends principally on the parameter $(\partial^2 C_{33}/\partial e_0^2)$. Comparison of theoretical results with the experimental data, which is mainly from neutron scattering experiments, shows that the data can be accounted for if $(\partial^2 C_{33}/\partial e_0^2)$ lies in the range 7 to $10 \times 10^{13}$ dynes/cm$^2$. A theoretical estimate of $(\partial^2 C_{33}/\partial e_0^2)$ based on Lennard–Jones potentials between atoms in adjacent basal planes gives a value of $9.07 \times 10^{13}$ dynes/cm$^2$. (auth)

**20507** LOW-TEMPERATURE ELECTRICAL RESISTIVITY CHARACTERISTICS OF FAST-NEUTRON-IRRADIATED CdS: NEW CONCEPTS IN NEUTRON DETECTION. Johnson, R. T. Jr. (Sandia Labs., Albuquerque, NM). Radiat. Eff.; 23: No. 1, 21-27 (Sep 1974).

Time-dependent electrical resistivity changes at low temperature in fast-neutron-irradiated CdS were studied. The experiments were on low-resistivity single crystals, and the electrical changes result from radioactive decay effects induced by the fast-neutron irradiation. Results show that following neutron irradiation and upon lowering the sample temperature, the resistivity decreases with time and approaches a stable value. These effects are attributed to trapping phenomena and can be erased by increasing the temperature. The time-dependent electrical changes associated with radioactive decay provide a new means for neutron detection. (auth)

**20508** STRUCTURE AND PROPERTIES OF RADIATION DEFECTS IN KCl, KCl : LiCl, AND KCl : NaCl CRYSTALS. Gorbenko, P. K.; Gromovoi, Yu. S.; Kovtun, A. A.; Teslenko, V. V. (Kiev Polytechnic Inst.). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 11, 1804-1807(Nov 1974). (In Russian).

Phenomena connected with radiation defects obtained by x and $\gamma$ radiation were studied by a complex method. In the pure KCl crystals no EPR and optical spectra were identified as the latter was not found in the frequency range corresponding to the spectrum from 1 to 6 eV. $H_A$- and $V_{KA}$-centers are shown to appear in KCl + 1 mol. % NaCl and KCl + 1 mol. % LiCl crystals. $V_{KA}$-centers are thermally more stable in comparison with $V_K$-centers in KCl, especially $V_{KA}$-centers in KCl : LiCl crystals. The diffusion haloid vacancies are shown to take place. The vacancies arise because of annihilation of $V_K$-centers with F-centers in KCl and $V_{KA}$-centers in KCl : LiCl crystals. The diffusion energy of haloid vacancies is determined. It corresponds to 0.385 eV. (auth)

**20509** RECOMBINATION OF MINORITY CHARGE CARRIERS IN n-TYPE SILICON DURING IRRADIATION WITH ELECTRONS. Korshunov, F. P. (Inst. of Solids and Semiconductors, Minsk). Dokl. Akad. Nauk BSSR; 18: No. 11, 980-983(Nov 1974). (In Russian).

A study was made of the effect of 25-MeV electrons on the recombination of minority carriers at high levels of injection in n-type silicon having a specific resistance of 0.1 to 250 ohm · cm. The silicon was alloyed with phosphorous and contained oxygen at a concentration of $5 \times 10^{17}$ cm$^{-3}$. It was established that the change in the reciprocal of the lifetime of the minority carriers during irradiation in silicon of varying specific resistance, including irradiation at different temperatures, is a linear function of the integral electron flux. The lower the specific resistance of the silicon and the lower the irradiation temperature, the greater is the rate of change in $\tau$. On invoking the theory of Hall–Schockley–Reed, the position of the main recombination level ($E_c - 0.17$ eV) is determined. The hole capture cross section on radiation recombination centers turned out to be equal to $\sigma_p = 1 \times 10^{-25}$ cm$^2$. It is shown that the relative arrangement of the recombination level and Fermi level determines the rate of change in the lifetime of minority charge carriers during irradiation of silicon. (SJR)

**20510** THERMOPHYSICAL PROPERTIES OF AMORPHOUS PHASE OF IRRADIATED POLYETHYLENE. Briskman, B. A.; Savina, V. P. Inzh.-Fiz. Zh.; 27: No. 5, 804-810(Nov 1974). (In Russian).

Based on the experimental data earlier obtained for the effect of irradiation and irradiation temperature on thermophysical properties of polyethylene, qualitative estimates are made of the effect of the absorbed dose and irradiation temperature on the plasticity of polyethylene and the density and heat capacity of its amorphous phase. (auth)

**20511** ENHANCEMENT OF THE ORIENTATION OF A MOLYBDENUM DISULFIDE SURFACE LAYER BY IRRADIATION AND THE CONSEQUENT ULTRALOW FRICTION WHEN COUPLED WITH A METAL. Aparin, V. I.; Dukhovskoi, E. A.; Ponomarev, A. N.; Silin, A. A.; Tal'roze, V. L. Dokl. Phys. Chem. (Engl. Transl.); 217: No. 1-3, 663-665(Jul 1974).

Translated from Dokl. Akad. Nauk SSSR; 217: No. 3, 599-601 (Jul 1974).

A study was made of the ultralow friction produced in $MoS_2$ layers by bombardment with accelerated He atoms (2 keV). Electron diffractions suggest that the orientation in the surface layer becomes more complete under the irradiation and mechanical effects. (DLC)

# NUCLEAR MATERIALS AND WASTE MANAGEMENT

**20512** (74-CNA-700, pp 12) HEAVY WATER MANAGEMENT. Nichols, M. J. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 7. Technical-scientific session.

Heavy water represents a considerable capital investment for Ontario Hydro. It currently owns or leases approximately 2,300 Mg, valued at $152,000. Clearly there is a need to ensure effective use and conservation of this capital asset. Management of heavy water includes the prevention of escape, the prevention of downgrading, the recovery of that which does escape, and its cleaning and upgrading. Each of these areas is discussed. Hydro's recent experience, particularly at Pickering GS, is detailed. The major lessons learned to date are: (a) escape is best minimized in the design stage by the elimination of potential leak-points; (b) some escape is inevitable, thus reliable and efficient recovery systems are essential; and (c) if upgrading costs are not to prove excessive, light water leakage in heavy water areas must be minimized. (auth)

**20513** MATERIALS MANAGEMENT: A PROGRAM IN REVIEW. Baranowski, F. P. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 34-48(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

An overview of the nuclear materials management program in the AEC is presented. Forces which "shape" and "reshape" the program are discussed. (TFD)

## Accountability and Safeguards

**20514** (KFK-1109) OPTIMIZATION OF SAFEGUARDS EFFORT. Avenhaus, R.; Frick, H.; Gupta, D.; Hartmann, G.; Nakicenovic, N. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik; Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Spaltstoffflusskontrolle). Aug 1974. 111p. INIS.

With figs. and tabs.; 18 refs.

The report contains the preparation and the mathematical treatment of an inspection model as well as a detailed application of the theoretical considerations to a reprocessing plant of the NFS type and a fabrication plant of the ALKEM type. In the theoretical part two possible means of diverting material are considered: diversion by means of falsification of data and diversion without falsification of data within the scope of measurement accuracy. In the first case two different statistical models are examined. The first provides for the inspector checking the operator's data by means of sample remeasurement. In the second model the inspector compares the sum of his data with the sum of all measurement data reported by the operator. This will be applied if it is no longer possible for the inspector to check the batch after it has been measured by the operator. Diversion without falsification of data within the scope of measurement accuracy is examined on the basis of material balance by single and double inventory. The inspector assumes an overall probability $\alpha$ of the error of the first kind which is divided for the first and second inventory due to the restriction $1-\alpha = (1-\alpha_1) \times (1-\alpha_2)$. It is assumed that the operator diverts the amount $M_1$ in the first and the amount $M_2$ in the second inventory period under the restriction $M = M_1 + M_2$. In one instance that is important because of its relevance to practical application it can be shown that the optimal inspector strategie $(\alpha_1^0, \alpha_2^0)$ is independent of the amount M. In Chapter III numerical examples are worked out using the reference plants data described in Chapter II. The examples are meant to demonstrate the possibilities and restrictions of the methods developed in Chapter I. This is achieved with the help of extensive parameter variations. (GE)

**20515** (MLM-2186) MOUND LABORATORY ACTIVITIES FOR THE DIVISION OF SAFEGUARDS AND SECURITY: JANUARY-JUNE 1974. (Mound Lab., Miamisburg, Ohio (USA)). 27 Dec 1974. Contract AT-33-1-GEN-53. 35p. Dep. NTIS $4.00.

Research and development progress are reported on the following: Pu isotopic measurements by gamma spectroscopy; calorimetric assay and specific power determination of $^{239}$Pu using metal exchange samples; calorimetric assay of plutonium nitrate solutions; automated Pu assay system; calorimetric development; van calorimeter; calorimetric assay of ZPPR fuel pins; audit verification program; and half-life measurement of $^{239}$Pu and $^{241}$Am. (TFD)

**20516** NUCLEAR MATERIAL CONTROL SYSTEMS FOR NUCLEAR POWER PLANTS. New York; American National Standards Institute, Inc. (1974). 9p. (ICONS-01939; ANSI-N-15.8-1974).

This standard establishes guidelines for the control, and accounting for quantities, of nuclear materials at nuclear power plants. The standard is applicable to light water reactors, high-temperature gas-cooled reactors, and breeder reactors. The guidelines set forth in this standard are applicable to special nuclear materials (SNM) and various material mixtures containing SNM. Generally, the nuclear materials involved are plutonium, $^{233}$U, and uranium enriched in the isotope $^{235}$U. The $^{235}$U enrichment used will vary depending on the type of reactor and various reactor parameters. These nuclear materials are normally in the form of dioxide or carbide pellets and are encapsulated in fuel rods. Guidelines are set forth for the fundamentals of a nuclear material control and accounting system, including criteria for the receipt, internal control, and shipment of nuclear material. (auth)

**20517** METAL DETECTION SYSTEM FOR PHYSICAL PLANT SECURITY. Ricci, R. J. (Intex Inc., Chevy Chase, MD). Nucl. Mater. Manage.; 3: No. 3, 370-379(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The principles and characteristics of metal detection systems and the significant parameters related to personnel screening requirements are described. Technical details of the principles involved for general detection of both ferrous and non-ferrous metallic objects are presented along with specific considerations governing the design and application of the Metor. Detection capability and performance criteria are discussed in terms of specific security applications and system parameters as applicable to various applications (e.g. airports, prisons, industrial plants, etc.). (auth)

**20518** SYSTEMS APPROACH TO PHYSICAL PLANT SECURITY. Doolittle, C. E. (Raytheon Service Co., Burlington, MA). Nucl. Mater. Manage.; 3: No. 3, 380-383(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The rationale, methodology and advantages inherent in the application of the system engineering approach to physical plant security systems development are described. In classical format, the systems approach encompasses an orderly progression of data collection and interpretation to identify and categorize unique characteristics of a security need. In close coordination with utility management and its design/construction team, the systems engineer executes an objective analysis in determining configuration influences, operational constraints, and performance options. Ideally, freedom from product bias and inventory limitations allows the systems engineer to select appropriate commercially available equipments based solely on established performance data and conformance to design criteria. From analysis to implementation phase, the dedicated systems approach entails a cohesive plan with defined milestones. Beyond the minimal satisfaction of regulatory guidelines, this approach further assures plant management of operational acceptance through early planning and comprehensive consideration of the candidate system's projected environment. (auth)

**20519** NEW APPROACH TO DOORWAY MONITORS. Weber, H. J., Soha, M. (Intelcom Rad Tech, San Diego, CA). Nucl. Mater. Manage.; 3: No. 3, 384-394(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A doorway monitor is described which was designed to detect the passage of $^{235}$U, $^{233}$U, or $^{239}$Pu through personnel portals without impeding the traffic flow through the portal. The sensitivity of the monitor is equal to or better than required by the specifications for doorway monitors detailed in USAEC Regulatory Guide No. 5.7. An alarm is provided for appropriate action by security forces. Several measures are taken by the programmable digital control processor to minimize the possibility of deception, and at the same time provide maximum sensitivity consistent with the ambient background level. The background and its statistical fluctuations are measured continuously, except when the portal is occupied; signals which occur when the portal is occupied cause alarms when they exceed the background with a predetermined statistical confidence. Additional fail-safe features result in alarms for most types of system malfunctions or attempts at tampering with the system. (auth)

**20520** NEW EQUIPMENT AND TECHNIQUES FOR PHYSICAL SECURITY AND ENVIRONMENTAL PROTECTION. Miller, H.; Shepard, S. H.; Untermyer, S. II. (National Nuclear Corp., Redwood City, CA). Nucl. Mater. Manage.; 3: No. 3, 395-405 (1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Protection of plutonium and enriched uranium is enhanced by the use of SNM door monitors. The performance of these door monitors has been established to meet AEC requirements and their application to plant operation has been broadened to provide convenience and effectiveness. Application of door monitors has included integration with occupancy monitors, metal detectors, television cameras, remote guard stations, and total plant protection systems. Environmental protection systems, such as the NNC liquid monitors, have been developed and applied to commercial plant applications for measuring plutonium and uranium concentrations in process and waste streams. (auth)

**20521** AEC EXPERIENCE IN APPLYING STRENGTHENED PHYSICAL PROTECTION REQUIREMENTS. Page, R. G. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 21-33(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

New requirements for the physical protection of special nuclear material against theft and nuclear plants against industrial sabotage were published in effective form on November 6, 1973. The new requirements applied to licensees who are authorized to use or possess at any site or contiguous sites special nuclear material consisting of uranium-233, plutonium, or uranium enriched to 20% or more in the $^{235}$U-isotope in a quantity of 5,000 g or more. The experience of the AEC in dealing with licensees in implementing the new regulations is presented. (TFD)

**20522** ROCKY FLATS SECURITY AND SAFEGUARDS SYSTEMS: VEHICULAR GATE MONITOR. Martinez, J. L.; Cunningham, G. J. (Dow Chemical, Golden, CO). AT(29-1)-1106. Nucl. Mater. Manage.; 3: No. 3, 416-425(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A prototype vehicular gate monitor has been constructed and tested. Details of construction, operation, and performance are discussed. (auth)

**20523** PANEL DISCUSSION ON USE OF SECURITY SEALS FOR SAFEGUARDS. Sastre, C. (Brookhaven National Lab., Upton, NY); Ovuka, N.; Gaitanis, M. J.; Hill, D. D.; Sorenson, R. J. Nucl. Mater. Manage.; 3: No. 3, 426-448(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Although the discussion covered the various types of seals used for tamper-proofing of containers, emphasis was placed on the problems of developing and using inexpensive paper seals. (TFD)

**20524** IMPLEMENTATION OF 10CFR PART 73. Low, L. D. (Nuclear Surveillance and Auditing Corp., Falls Church, VA). Nucl. Mater. Manage.; 3: No. 3, 82-91(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Problems associated with the implementation of 10 CFR Part 73, the new rule the USAEC adopted for the physical protection of plants and materials are presented. Areas in which the rule specifies "to much" or "too little" protection are discussed. (TFD)

**20525** PROTECTION OF LICENSE-EXEMPT SPECIAL NUCLEAR MATERIAL. Hightower, E. D. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 72-81(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Procedures for safeguarding license-exempt amounts of special nuclear material are discussed. (TFD)

**20526** CHANGING ROLE OF SAFEGUARDS. McDowell, S. C. T.; Bartels, W. C. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 63-71(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The threat of national and international terrorist groups acquiring sufficient material to fashion a crude bomb or radiological weapon is discussed. Development of safeguards equipment and methods for averting this threat is discussed. (TFD)

**20527** INVISIBLE MAN(AGERS). Miles, E. J. (Westinghouse Electric Corp., Pittsburgh). Nucl. Mater. Manage.; 3: No. 3, 8-11(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The members of safeguards teams are described as being inconspicuous and receiving little publicity. On the other hand the risks involved concerning safeguards are pointed out daily in most news media. The release of more information on the positive side of safeguards programs is advocated. (TFD)

**20528** FAST-RESPONSE FUEL ROD CALORIMETER FOR 36 INCH FUEL COLUMNS. Beyer, N. S.; Lewis, R. N.; Perry, R. B. (Argonne National Lab., IL). Nucl. Mater. Manage.; 3: No. 3, 118-130(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The primary interest in fuel rod calorimeters is due to the high measurement precision attainable with such instrumentation. However, for this interest to be sustained by those who need to make safeguards-type inventory control measurements, it must have a relatively fast measurement-response-time. The design features and the results of evaluation tests of a new, fast response, fuel rod calorimeter that can be used to nondestructively measure a 36 inch fuel column (FFTF size) of mixed-oxide fuel are described. With this instrument measurements can be made in 13 to 23 minutes with an accuracy of ±0.12 to 0.13% relative. (auth)

**20529** NDA MEASUREMENT ERROR DUE TO INSTRUMENT CALIBRATION. Smith, D. B.; Forster, R. A. (Los Alamos Scientific Lab., NM). Nucl. Mater. Manage.; 3: No. 3, 131-139 (1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A meaningful quantitative measurement program for nuclear materials control requires not only instrumentation to assay special nuclear material, but also the ability to determine a statistically defensible estimate of the uncertainty in that assay. Expressions are presented which estimate the contribution from calibration to the uncertainty in the assay of both a single inventory item and an entire inventory. The latter case must include the fact that the results for all items assayed using the same calibration curve are correlated. A Monte Carlo model of the calibration-assay procedure which has been developed confirms the ability of these expressions to properly estimate the uncertainty due to calibration. This model and the results obtained are presented along with examples of the magnitude of this contribution. (auth)

**20530** NDA MEASUREMENT OF LOW-LEVEL U AND Pu WASTE. Umbarger, C. J.; Walton, R. B.; Foley, J. E.; Cowder, L. R. (Los Alamos Scientific Lab., NM). Nucl. Mater. Manage.; 3: No. 3, 140-150(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The accurate analysis of low-level U and Pu wastes in a routine manner is an important step in implementing effective waste management and nuclear materials accountability programs. Several gamma ray and neutron based detection systems presently being used at LASL for analysis of such wastes are described. (auth)

**20531** FIELD ASSAY OF PLUTONIUM WITH A NEW COMPUTERIZED SEGMENTED GAMMA SCAN INSTRUMENT. Martin, E. R. (Los Alamos Scientific Lab., NM); Jones, D. F.; Speir, L. G.; Walker, A. C. Nucl. Mater. Manage.; 3: No. 3, 151-170(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

An automated passive gamma scanner for NDA is described, engineered around a minicomputer and an automated scan table. The computer permits virtual hands-off operation and offers a segment-by-segment profile of fissile content, as well as an estimate of the propagated statistical measurement error. Since the measurement is transmission corrected on a segment-by-segment basis, a wide variety of container sizes and material matrices can be accommodated, permitting two-percent measurements on scrap and waste samples containing between five and five-hundred grams of fissile material. Field tests of the new instrument at ARHCO in Richland, Washington, are also described. (auth)

**20532** NDA OF HTGR FUEL USING THE RANDOM DRIVER. Atwell, T. L.; Foley, J. E.; East, L. V. (Los Alamos Scientific Lab., NM). Nucl. Mater. Manage.; 3: No. 3, 171-188(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The use of an active neutron source interrogation system known as Random Driver for the nondestructive assay of uranium in HTGR (in-process) fuel particles is discussed. The system employs a random source of fast neutrons consisting of four

AmLi ($\alpha$,n) sources to induce fissions in the $^{235}U$ present. Fission events are detected by coincidence counting a prompt-fission neutrons using a pair of fast plastic scintillation detectors. A PDP-11/05 minicomputer is used for data acquisition and reduction. Details of the assay system and preliminary results on the assay of HTGR fuel particles are presented. (auth)

**20533** CHARACTERISTICS AND PERFORMANCE OF UPGRADED ISAS. Selleck, E. G.; Gozani, T. (Intelcom Rad Tech, San Diego, CA). Nucl. Mater. Manage.; 3: No. 3, 189-202(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The Isotopic Source Assay System (ISAS) utilizes the detection of the multiplicity of fission events to quantitatively measure the fissile content of fuels and scrap materials. Advantages obtained through the use of this nondestructive system include stability, sensitivity, and ease of operation. The upgrading of the ISAS has been essentially an advancement in its stability or its selectivity, i.e., the development of a technique for measuring pseudofission events arising from a variety of sources. Once these events have been measured they can be handled as backgrounds in a conventional manner, thus broadening the domain of ISAS applicability and increasing its precision. (auth)

**20534** LEACHED HULL MONITOR FOR DETECTION OF UNDISSOLVED IRRADIATED NUCLEAR FUEL. Gozani, T. (Intelcom Rad Tech, San Diego, CA). Nucl. Mater. Manage.; 3: No. 3, 203-216(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A new Leached Hull Monitor (LHM) featuring high sensitivities, wide applicability to various kinds of reactor fuels, and excellent suppression of interference, was built and tested at Rad Tech. The purpose of a LHM is to detect the presence of undissolved fuel in chopped hulls of irradiated fuel elements after a proper leaching time. The monitor detects the presence and measures the amount of the fission product, $^{144}Ce$. This isotope has a high cumulative yield of 6%, and a half life of 285 days. Its daughter product, $^{144}Pr$, emits several distinctive gamma-ray lines, the highest of which has an energy of 2186 keV, and a rather low yield of 0.74% per disintegration. The LHM detects this passive radiation which is the most penetrating and least sensitive to interference from other radiations. The interference comes mainly from activities induced in the fuel cladding by neutron captures. The most important induced activity in Zircaloy cladding of light-water reactor (LWR) and stainless-steel cladding of fast-breeder reactor (FBR) fuel rods is $^{60}Co$. Other interferences of less importance are $^{58}Co$, $^{95}Zr$, $^{95}Nb$, and some fission-related products such as $^{106}Ru$ and $^{137}Cs$. The new LHM reduces substantially this interference by using a fast-slow electronics system, a proper gamma-ray filter, and a rotation-collimation plus vertical-scanning system. The main components of the system are: a gamma-ray spectrometer [NaI(Tl) or Ge(Li)], a fast-slow electronic signal processing system, analog and digital outputs for gross and net cerium response, and a remotely positioned source for calibration and normalization. Performance of the system in terms of the suppression of interference and sensitivity was demonstrated in an extensive series of measurements simulating an actual LWR irradiated fuel. Based on the tests, the minimum detectable amount of undissolved uranium for typical high and medium burnup LWR fuel (>25000 MWD/T) under ideal conditions (i.e., all the detected Ce is related to residual fuel), has been estimated. Very high sensitivity to Ce, and hence to residual fuel, has been demonstrated. Some inherent problems with the passive LHM are discussed, along with methods to diminish their effect. (auth)

**20535** NEAR- AND LONG-TERM APPLICATIONS OF NONDESTRUCTIVE ASSAY TO SPECIAL NUCLEAR MATERIALS ACCOUNTABILITY. Shea, T. E.; Glancy, J. E. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 228-235(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Special requirements for the control and accountability of special nuclear materials for AEC licensed processing facilities are stipulated in Part 70 of Title 10 of the Code of Federal Regulations. This paper addresses the role of nondestructive assay in meeting those requirements. The discussion is based on considering issued and proposed Regulatory Guides related to nondestructive assay. The content, scope, and philosophy embodied in those guides are discussed, and comments solicited. Nondestructive assay presents a unique opportunity to further improve special nuclear materials control and accounting in licensed processing facilities. The unique capabilities of NDA are examined in the context of prompt, localized accounting. (auth)

**20536** PRACTICALITY OF DIVERSION PATH ANALYSIS. Murphey, W. M.; Schleter, J. C. (National Bureau of Standards, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 236-268(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Maintenance of effective safeguards requires a program for routine assessment of plant safeguards systems in terms of their capabilities to satisfy safeguards aims. Plant internal control systems provide capabilities for detection of unprevented diversion and can provide assurance that diversion has not occurred. A procedure called Diversion Path Analysis (DPA) enables routine assessment of the capabilities of internal control systems to indicate unprevented diversion and identification of safeguards problem areas in a plant. A framework for safeguards system design is also provided which will allow flexibility to accommodate individual plant circumstances while maintaining acceptable diversion detection capability. The steps of the procedure are described and the practicality of the analytical procedure is shown by referring to a demonstration test for a high throughput process where plant personnel were major participants. The boundary conditions for the demonstration case are given, along with some conclusions about the general procedure. (auth)

**20537** MEASUREMENT CONTROL PROGRAM FOR NUCLEAR MATERIALS ACCOUNTING. Brouns, R. J. Roberts, F. P.; Schneider, R. A. (Battelle Pacific Northwest Labs., Richland, WA). Nucl. Mater. Manage.; 3: No. 3, 288-297(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The function of a measurement control program for nuclear materials accounting is to monitor and control the quality of the SNM measurements that are involved in material balances. The quality is monitored by collecting data from which current measurement error variances (both random and systematic) can be calculated and is controlled by evaluations, reviews and other administrative measures. The most important elements of a program by which management can monitor and control measurement quality are described. (auth)

**20538** COMPUTERIZED RECORD-KEEPING PROGRAM: ISOTOPE INVENTORY RECORDS. Lorio, P. M. (Columbia Univ., New York). Nucl. Mater. Manage.; 3: No. 3, 298-307 (1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The utilization of radioactive materials for research and teaching at Columbia University is performed under a "broad" license issued by the Office of Radiation Control in New York City. The Health Physics Office at Columbia University administrates the broad license. Members of the faculty with the necessary training and experience are classified as Responsible Investigators and can request a Health Physics Authorization Number for one or more isotopes. Approval of these requests by the University Radiation Safety Committee is given after an evaluation of the amount of material to be used, location of use, available experimental facilities and previous experience of the Responsible Investigator has been made. The Health Physics Office maintains a record of these authorizations. All requisitions for radioactive materials must be approved by the Health Physics Officer prior to their conversion to purchase orders by the Purchasing Department. All radioactive materials shipped to the University are addressed to the Health Physics Office. Upon receipt of a shipment, the personnel in the Health Physics Office perform an incoming shipment survey. A shipment number is assigned to the package and it is inventoried into a computerized system. (auth)

**20539** MODELING, SIMULATION, AND ESTIMATION FOR REAL-TIME MATERIALS CONTROL. Pomernacki, C. L.; Sanborn, R. H.; Magistad, J. G.; Frazer, J. W. (Univ. of California, Livermore). Nucl. Mater. Manage.; 3: No. 3, 308-319(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The utility of modeling and simulation for the safeguards aspects of Nuclear Fuel Processing Facilities is two-fold in nature. First, a model can be used to simulate plant operations to aid in the development of instrument and automation system specifications. Second, a model can be used in conjunction with on-line operations as an integral part of an automated estimation procedure for position-identification of special nuclear materials. Ultimately the gains of a real-time materials control plan would be realized through its compatibility with automated process operations as well as through increased confidence in a safeguards system which responds in a timely manner. In addition, the increased credibility of an on-line data gathering and estimating system could result in more process compatible physical inventory requirements. (auth)

**20540** NEW AUTOMATED ACCOUNTABILITY SYSTEM FOR SS MATERIAL AT DOW CHEMICAL, ROCKY FLATS DIVISION. Bowman, B. A.; Bartlett, J. B. (Dow Chemical, Golden, CO). Nucl. Mater. Manage.; 3: No. 3, 320-324(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

During July, 1968, an automated data processing system for SS material control was initiated at The Dow Chemical Company, Rocky Flats Division. During Fiscal Year 1973, the findings of a Management Systems Feasibility Study resulted in the decision to develop and implement "an advanced," automated accountability system for SS material. A full-time project team (five members including the project manager) was established in May, 1973, and has been working on the developmental aspects of the system. (auth)

**20541** MAKING OF AN ANSI STANDARD. Ferris, Y. M. (Dow Chemical, Golden, CO); Suda, S. C. Nucl. Mater. Manage.; 3: No. 3, 325-332(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The purpose of this paper is to inform the members of the Institute of Nuclear Materials Management (INMM) of the effort involved and the constraints imposed in preparing a standard. Described are the structure of the American National Standards Institute (ANSI), the mechanics of writing a standard, the roles of the subcommittee members, and the insights and experiences of the task force on the Volume Calibration Techniques for Nuclear Materials Control. These experiences were extended by interviewing the chairman of other ANSI subcommittees. Results of this survey are quantified and evaluated. The information presented will benefit those members of the Institute called upon to review completed standards as well as prospective members of a standards subcommittee. (auth)

**20542** CONTAINER STANDARDIZATION: KEY TO A MATURING NONDESTRUCTIVE ASSAY APPROACH. Bishop, D. M. Nucl. Mater. Manage.; 3: No. 3, 333-340(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

It is suggested procedural, not technological, criteria inhibit the broad-based implementation of nondestructive assay techniques within the nuclear community. Difficulty in comparing test results is identified as a primary shortcoming in the nondestructive assay approach. Development of bases for assuring measurement uniformity is proposed as an important prerequisite to solving the comparability problem. The role and relation of contributing variables to measurement uniformity are defined. The standardization of containers for key process applications within the nuclear industry is identified as a primary step toward attaining measurement uniformity. Strong INMM-ANSI involvement in establishing container selection criteria is proposed. (auth)

**20543** REDUCTION, CONTROL, AND ESTIMATION OF NONDESTRUCTIVE ASSAY ERRORS. Shea, T. E. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 341-350(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The composite error associated with the application of nondestructive assay to special nuclear materials accountability is separated into three distinct components. The components are considered in terms of hierarchy of contributing factors. By examining the hierarchy, methods are generalized for the reduction of the component errors through instrument design features and the implementation of appropriate assay control procedures. The use of auxiliary measurements is discussed as a means to further reduce and evaluate the contribution of potential error sources to the composite NDA error. (auth)

**20544** TRACEABILITY OF NONDESTRUCTIVE ASSAY TO THE NATIONAL MEASUREMENT SYSTEM. Glancy, J. E. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 351-360(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The concept and definition of traceability to the national measurement system is discussed. Traceability is considered a flexible, general term which only has meaning when the method used to trace the measurement results is clearly defined. Methods are proposed which provide the ability to show the consistency of any NDA measurement system with national plutonium and uranium standards. The difficulties in using working or industry NDA standards to provide traceability are discussed. Comparative measurements are proposed as the essential step in attaining a consistent national NDA measurement system and as the replacement for primary NDA standards. (auth)

**20545** SOME FUNNY THINGS HAPPENED ON THE WAY TO THE LIMIT OF ERROR STANDARD. Moore, R. H. (Los Alamos Scientific Lab., NM). Nucl. Mater. Manage.; 3: No. 3, 361-369(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A singular view of the concept of "limit of error" and its several interpretations within the nuclear materials industry is presented. A description and discussion of an American National Standard on limit of error concepts are included. (auth)

**20546** FISSION MULTIPLICITY DETECTOR FOR PLUTONIUM WASTE. Weber, H. J. (Intelcom Rad Tech, San Diego, CA). Nucl. Mater. Manage.; 3: No. 3, 107-117(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A fission multiplicity detector (FMD) system was developed for the passive assay of the plutonium content of known isotopic composition in low-level hydrogenous waste materials contained in 55-gallon drums. It utilizes the fact that $^{240}Pu$ emits an average of seven prompt gamma rays and 2.5 neutrons per spontaneous fission event. The system was specifically designed to combine rugged mechanical construction and simplicity of operation with sensitivity to 1 g of fissile Pu, corresponding to 0.1 to 0.2 g of $^{240}Pu$, as well as the ability to function in a high background environment, while providing good spatial uniformity of the detector response. It consists of a barrel-handling assembly, the FMD, and electronic logic interfaced into a programmable desk calculator for data acquisition and reduction. (auth)

**20547** PRACTICAL PROBLEMS IN THE USE OF STATISTICAL TECHNIQUES IN SAFEGUARDS. Lovett, J. E. Nucl. Mater. Manage.; 3: No. 3, 49-62(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

Which statistical techniques to use, and how to use them, has been the subject of many discussions, in panel meetings, in working groups, in published papers and reports, and in informal meetings within the Agency. This presentation is not intended to summarize or contribute to those discussions. Although some of the techniques can be described quite simply; others are quite advanced, and even a general presentation can be both time-consuming and complex. All statistical techniques, however, have one general principle in common. They assume that certain conditions exist which permit the extrapolation of data from a relatively few items, called a sample, to the entire collection of material being safeguarded, called a population or a universe. These assumptions are perhaps well understood by the expert statisticians, but they are not commonly discussed in detail. Some practical problems which are more or less common to all of the many statistical techniques which have been suggested are discussed. Although the techniques themselves are of great importance, in the end it will very likely be an ability to solve the practical problems that will determine the success or failure of statistics in safeguards. The problem areas discussed include: random sampling; ability to verify an item; independence of data; availability of detailed statistical data; and separation of error variances. (TFD)

**20548** SMALL SAMPLE ASSAY SYSTEM. Gozani, T.; Ingraham, C. N. (Intelcom Rad Tech, San Diego, CA). Nucl. Mater. Manage.; 3: No. 3, 92-106(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A new high-precision assay system for fissile nuclear material has been built. The new system, called Small Sample Assay System (SSAS), is based on the principle of thermal (or epithermal) neutron activation analysis, where the observed response is the delayed fission gamma rays emitted from the fission product a few seconds to a few minutes after the fission. The system takes advantage of the high initial yields of the delayed gamma rays by starting the counting very shortly after the end of the irradiation. The SSAS operates with a basic timing cycle which begins with a background measurement, continues by irradiating the sample in the neutron flux of a properly moderated $^{252}Cf$ source, and concludes with a measurement of the signal plus background. The basic physics of the system, which makes efficient use of the delayed gamma spectrum and time dependence, yield very high count rate per gram of fissile material, even when moderately small Cf sources (10 to 50 $\mu g$) are employed. The SSAS can be operated with either or both of two types of electronic processing systems. The basic system employs a dead-time-less technique which allows handling of high count rates and intrinsically gives increased weight to the higher energy portions of the gamma spectrum, thus reducing the gamma self shielding. The other system involves a fast linear system which retains pulse-height information, found to be a very useful feature, especially for mixed oxide pellets. The prototype SSAS was subjected to an intensive series of tests

aimed at determining the precision of the device and its reliability. Extensive tests to determine the precision of the SSAS were performed with sintered LWR pellets and $UO_2$ powder spanning the enrichment range from natural to 3.3%. The results show that the typically obtained precision is about 0.5 and 1% at the 1-$\sigma$ confidence level for pellets and oxide powder, respectively. (auth)

**20549** SAFEGUARDS AND PLUTONIUM RECYCLE. Smiley, S. H. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 3: No. 3, 12-17(1974).

From 15th annual meeting of the Institute of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

The production and recycle of Pu and problems of safeguards are discussed. (TFD)

## Disposal and Storage

*Refer also to abstracts 19360, 19362, 19550, 19680, and 20096.*

**20550** (DHEW/FDA-75-8010, pp 56-62) REPORT OF THE TASK FORCE ON RADIOACTIVE WASTE MANAGEMENT. Cashman, T. J.; Brunner, P.; Christie, M. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Progress is reported in the development of recommendations for the management of radioactive wastes in such a manner that there will be no health hazard. Certain fundamental concepts for commercial radioactive waste burial sites are summarized. (CH)

**20551** (DP-1358) LEAKAGE FROM WASTE TANK 16: AMOUNT, FATE, AND IMPACT. Poe, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Nov 1974. Contract AT(07-2)-1. 145p. Dep. NTIS $5.45.

On September 8, 1960, a small amount of high activity waste leaked from Tank 16 at the Savannah River Plant and reached the surrounding soil. Calculations based on the measured ground water flow velocities, estimated flow paths, and the measured ion exchange capabilities of soil samples indicate that the radionuclides that leaked into the ground will decay before reaching the nearest creek, and thus will have no effect on the public. Intensive investigation and monitoring since 1960 confirm that only a few tens of gallons of waste entered the soil. This waste contained 7.4 Ci of radionuclides (85% $^{137}Cs$) per gal. The radioactivity in the leaked waste reached the ground water almost immediately but has moved only a few ft since 1960. The radioactivity level in the ground water 15 ft from the edge of the concrete construction pad under Tank 16 is about ten times background, and between $2 \times 10^{-4}$ and $4 \times 10^{-4}$ Ci of radioactivity have moved beyond this point. No radioactivity increase has been observed in wells 1700 to 2800 ft from this tank. (auth)

**20552** (ORNL-TM-3277) SOURCES OF TRANSURANIUM SOLID WASTE AND THEIR INFLUENCE ON THE PROPOSED NATIONAL RADIOACTIVE WASTE REPOSITORY. Godbee, H. W.; Nichols, J. P. (Oak Ridge National Lab., Tenn. (USA)). Jan 1971. Contract W-7405-eng-26. 110p. Dep. NTIS $8.50.

This report presents estimates of sources of transuranium solid wastes in the United States and an evaluation of the quantities of these wastes that are conditionally acceptable for receipt at the Alpha Facility of the Proposed National Radioactive Waste Repository in Lyons, Kansas. It is assumed that transuranium solid waste has transuranium alpha radioactivity of greater than 10 $\mu$Ci/kg. This assumption has the effect of excluding most of the very large volume of waste that is generated within the normally occupied work areas of transuranium processing and fabrication plants. It is assumed that wastes containing less than 10 $\mu$Ci/kg of transuranium nuclides will continue to be buried on site or shipped, generally as LSA or Type A Quantity material, to surface burial grounds. It is assumed that transuranium wastes that have excessive unit size or radiation level for receipt at the repository will be stored or buried on site in a potentially retrievable form separate from nontransuranium wastes. These types of transuranium waste are generated predominantly at AEC or commercial plants for reprocessing spent fuel and, as generated, are primarily a hazard because of their fission product content. (auth)

## Handling Equipment and Procedures

**20553** (RN-TM-0128) PROPERTIES OF AISI TYPE 347 STAINLESS STEEL ABOVE 1500°F. (Aerojet-General Corp., Sacramento, Calif. (USA)). 19 Aug 1964. 11p. Dep. NTIS $4.00.

The mechanical properties of 347 stainless steel are described in tables, charts, and technical discussions. (JRD)

**20554** (Y-DR-129) NUCLEAR CRITICALITY OF INTERSECTING CYLINDERS OF AQUEOUS URANYL FLUORIDE SOLUTIONS. Johnson, E. B. (Oak Ridge Y-12 Plant, Tenn. (USA)). 31 Oct 1974. Contract W-7405-eng-26. 33p. Dep. NTIS $4.75.

The first experimental determinations of the criticality of aqueous solutions of uranyl fluoride, in which the uranium was enriched to 5% in $^{235}U$, in intersecting cylinders have been made. These experiments were designed to provide benchmarks for calculational methods. Two types of intersections were investigated: a 30° lateral formed by cylinders about 28 cm in diameter and a cross formed by cylinders of four diameters, between 26.7 and 28.6 cm. Solution concentrations between 907 and 745 g of uranium per liter were made critical. Comparison of KENO calculations, using two different cross-section sets, with the experiments showed generally very good agreement. (auth)

**20555** STORING DEVICE FOR FUEL ASSEMBLIES. Suvanto, A. (to AB Asea-Atom). US Patent 3,859,533. 7 Jan 1975. Priority date 21 Dec 1972, Sweden. 2p.

A storing device for fuel assemblies including a supporting grid with a substantially square lattice and a plurality of tubes of substantially square cross-section each adapted to contain one fuel assembly is described. There are retaining devices for holding tubes in position with respect to the grid. The walls of the tubes are coated with absorbing material. Each of the retaining devices is arranged to hold a pair of mutually parallel walls of different tubes having a gap between them, with the walls crossing a side of the lattice. The gap contains a layer of absorbing material, and is sealed water-tightly at the top and bottom portions of the gap. (Official Gazette)

## Transportation

*Refer also to abstracts 19562 and 19575.*

**20556** (DPSPU-74-124-6) SAFETY ANALYSIS REPORT: PACKAGES, SRL 4.5-TON CALIFORNIUM SHIPPING CASK (PACKAGING OF FISSILE AND OTHER RADIOACTIVE MATERIALS). Final Report. Whatley, V. Jr.; Mahoney, D. J.; Livingston, J. T. (Comps.). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Plant). Dec 1974. Contract AT(07-2)-1. 84p. Dep. NTIS $7.25.

A shielded cask especially designed for shipping californium-252 neutron sources is basically a spherical steel shell filled with water-extended polyester as the shielding material. The cask complies with requirements for shipping "large quantities" of radioactive materials as described in AEC Manual, Chapter 0529, "Safety Standards for Packaging of Radioactive and Fissile Materials." The cask also complies with IAEA "Regulations for the Safe Transport of Radioactive Materials," 1973 Revised Edition. (auth)

**20557** (K-D-1894) ORGDP CONTAINER TEST AND DEVELOPMENT PROGRAM. Fire Tests of $UF_6$-Filled Cylinders. Mallett, A. J. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 12 Jan 1966. Contract W-7405-eng-26. 25p. Dep. NTIS $4.50.

Fire tests of bare, $UF_6$-filled shipping cylinders were conducted at the ORGDP Rifle Range during October 1965 as part of the AEC-ORO Container Test and Development Program presently under way at the ORGDP. The multipurpose effort was to determine if the cylinders would hydrostatically or explosively rupture; the time available for fire fighting before either incident occurred; and the degree of contamination as related to the type of $UF_6$ release, wind velocity, and terrain. In addition to the cylinder fire tests, other tests were made for further evaluation of the fire-resistant BOX foam plastic. These included a newly designed shipping drum for 5-in.-diam cylinders, and 15B-type wood shipping boxes for small containers. In one case, the latter contained a $UF_6$-filled Harshaw cylinder. The test times ranged from 45 to 95 min. In no instance did temperatures exceed 200°F. Two each of the following types of cylinders were tested: 3.5 in. diam × 7.5 in. Monel Harshaw, 5.0 in. diam × 30 in. Monel, and 8 in. diam × 48 in. nickel. Fill limits were 5, 55, and 250 lb of $UF_6$, respectively, at an enrichment level of 0.22%. The larger cylinders were tested individually, with and without their metal valve covers. In the case of the small Harshaw cylinders and the uncapped 5-in.-diam cylinder, $UF_6$ releases occurred as a result of valve failure; the remaining cylinders ruptured explosively in a time interval of 8.5 to 11.0 min. The general type of test and results obtained are shown in photographs. (auth)

**20558** (SAND-74-0317) ANALYTICAL INVESTIGATION OF A GRADE-CROSSING ACCIDENT BETWEEN A RAILROAD TRAIN AND A SPENT REACTOR FUEL CASK. Dennis, A. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 59p. Dep. NTIS $6.00.

A General Electric IF-200 spent fuel shipping cask has been investigated using static and dynamic structural analysis methods to determine if an accident involving it and a railroad train traveling 80 mph would result in the release of spent reactor fuel. The primary investigation was centered upon the cask in its normal shipping configuration. It was concluded that the cask would not release spent fuel in the event of the currently most probable impact condition, i.e., the cask being impacted by the locomotive superstructure. The investigation was then extended to determine a set of conditions under which the cask might be breached. (auth)

**20559** TRANSPORT EXPERIENCE OF EDLOW INTERNATIONAL COMPANY UNDER PART 73, SECURITY TRANSPORT REGULATIONS. Edlow, J. Nucl. Mater. Manage.; 3: No. 3, 406-415(1974).

From 15th annual meeting of the Institue of Nuclear Materials Management, Inc.; Atlanta, GA (19 Jun 1974).

A general criticism of Part 73 of 10 CFR, Security Transport Regulations is presented. The main criticism put forward is that the regulations do not provide protection against a significant (large force) attack against nuclear materials in transit. A proposed solution to this problem is the establishment of a Federal protective force for safeguarding special nuclear materials. (TFD)

**20560** ARE THE GERMANS SAFE FROM RADIOACTIVE RAYS? Bruns, K. Welt (Hamburg); No. 94, 20(Apr 1974). (In German).

The atomic danger predicted only recently by the Ford Foundation due to self-made A-bombs from stolen fissionable material has not yet become reality. But what is even more ghastly because they are silent and invisible, are the now known attacks on the Austrian express trains with radioactive material. (auth)

# PARTICLE ACCELERATORS

## Design, Development, and Operation

*Refer also to abstracts 20904 and 21046.*

**20561** (74-CNA-200, pp 20) TRIUMF PROGRESS REPORT, MAY 1974. Burgerjon, J. J. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-200.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 2. CANDU program and research installations.

TRIUMF is a proton cyclotron nearing completion at the University of British Columbia. It will be used for nuclear physics and irradiation research. The cyclotron accelerates negative hydrogen ions to 500 MeV, after which they are stripped of electrons by passing them through a thin carbon foil. Details of the supports, magnet, magnetic field, ion source, resonators, extraction probes, beamlines, beam dumps, and radiation shielding, etc., are given, with photographs and drawings. Some of the problems experienced with transport, construction, and the power supply, are explained. TRIUMF is one of three such installations in the world, but has some unique features. (INIS)

**20562** (KFK-2059) EXPERIMENTAL INVESTIGATIONS ON THE STABILITY OF RELATIVISTIC ELECTRON RINGS. Zernial, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik). Oct 1974. 47p. (In German). Dep. NTIS (US Sales Only) $5.50.

Thesis.

At the Karlsruhe electron ring accelerator, experimental investigations were done on the stability of relativistic electron rings. At an initial momentum of the electrons of 2.8 MeV/c and a ring radius of R = 20 cm collective instabilities limit the electron number at about $7 \times 10^{12}$. The energy and number of electrons and the ring dimensions were measured by the ring self field and synchrotron radiation. The holding power of the fully compressed rings has been determined to $7 \times 5$ MeV/m. (auth)

**20563** (RL-74-148) NIMROD OPERATION AND DEVELOPMENT. Quarterly Reports: January 1-March 31, 1974; April 1-June 30, 1974. Gray, D. E. (ed.). (Science Research Council, Chilton (UK). Rutherford Lab.). 1974. 17p. Dep. NTIS $4.00.

The Nimrod beam was on for High Energy Physics Research for 83.4% of HEP scheduled operating time. Four experiments continued through and one was resumed. Some statistics relating to personal radiation dosimetry are presented. A progress report on the new 70 MeV injector for Nimrod is given. (auth)

**20564** FUNDAMENTAL ASPECTS OF RADIOPROTECTION AROUND HIGH ENERGY ACCELERATORS. Dutrannois, J.; Baarli, J. (CERN, Geneva). J. Belge Radiol.; 57: No. 4, 317-324(1974). (In French).

The most important task of a health physics department is the correct evaluation of radiation hazards from which precautions and limitations can be recommended. Around high-energy accelerators, radiations are complex and the energy spectra involved are extremely wide; every external dosimetry problem for every kind of particle at all energies arise. The authors examine the case of operating and nonoperating accelerators and describe the personnel and environment surveys. (auth)

**20565** TRIUMF ANNUAL REPORT, 1973. Vancouver, B. C.; University of British Columbia (1974). 64p.

Progress on the construction of the TRIUMF cyclotron for 1973 is reported. The major problem encountered was reduction of the errors in the field of the as-built magnet to tolerable levels. The central region cyclotron was able to accelerate 100 $\mu$A of $H^-$ ions to the full maximum energy of 3 MeV and the main cyclotron ion source achieved production of 100 $\mu$A at 300 keV. (CA)

**20566** ACCELERATING SYSTEM OF AN AUTORESONANT ACCELERATOR. Ishkov, A. P. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 12-14(1973). (In Russian).

The accelerating system of an autoresonant accelerator, based on a rectangular $120 \times 110$ mm waveguide with horn matching, was studied. The study showed that electrons can be accelerated up to energies of several MeV with this accelerating system. (INIS)

**20567** SPECIFIC PROBLEMS OF RADIOPROTECTION AROUND CYCLONE. Debauche, A.; Gillet, R. (Univ., Louvain, Belg.). J. Belge Radiol.; 57: No. 4, 325-332(1974). (In French).

Quite a few problems arose during the 2 years of intensive operation of the isochronous cyclotron of Louvain-la-Neuve. The most important difficulties were of two types: first, the activation of parts submitted to the direct beam or to diffused neutrons has taken unexpected importance; and second, some shielding was defective and had to be quickly improved. (auth)

## Auxiliaries and Components

*Refer also to abstract 19726.*

**20568** (UCRL-76468) LINAC DATA ACQUISITION SYSTEM. Mattesich, G. T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. 8p. (CONF-741001-46). Dep. NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

With the advent of the Linac, Lawrence Livermore Laboratory's 100 MeV Linear Accelerator, many constraints appeared which dictated the way the Linac Data Acquisition System would be developed. Experimentors at the Linac take advantage of a very high positron intensity, an exceptionally high variable-energy monochromatic gamma-ray flux, and a superior neutron intensity for neutron physics research. The Data Acquisition System is interactive with the experiment in a Real-Time Environment. The system is required to process analog and digital inputs representing Pulse-Height-Analysis and Time-of-Flight information from the experiment, respond to digital control signals from the experiment controllers, and provide digital outputs for experiment and machine control. The Linac DAS has grown in an evolutionary manner from a single DEC PDP8/I computer into a minicomputer network comprised of two PDP8's and a PDP-15. The original PDP8/I is the experiment control computer and the input port to the larger PDP-15. The system can service up to four Time-of-Flight experiments simultaneously. The experiments are connected to one of four hardware/software selectable input buffers. One of the four buffers is fed by a PDP8/e computer that can function as stand-alone data collection device or as an element of the Linac DAS. (auth)

**20569** MEASURING SYSTEMS FOR LOW CURRENTS. IV. Moskalev, V. A.; Shestakov, V. G. pp 54-53 of Kontrol' i Izmerenie Parametrov Puchkov Zaryazhennykh Chastits. Moscow; Atomizdat (1973). (In Russian).

The most frequently used methods are discussed for integrating and converting signals from charged-particle beams monitors by the use of electronic equipment such as current integrators and electrometric and pulse measuring equipment for accelerators. (INIS)

**20570** EFFECT OF THE GAP WIDTHS BETWEEN THE ROTOR AND THE STATOR, AND THE ROTOR AND THE BRUSH ON THE SHORT CIRCUIT CURRENT OF A DISK ROD ELECTROSTATIC GENERATOR. Kalganov, A. F.; Podpletneva, E. A.; Sivkov, Yu. N. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 62-65(1973). (In Russian).

The dependence of the maximum short circuit current of one-disc rod electrostatic generators on the size of the gap between rotor and stator during contact switching and on the size of the gap between the collector part of the rotor and the brush during gas-discharge switching was experimentally determined. (INIS)

**20571** CHOICE OF MINIMUM NUMBER OF CONTROLLABLE PARAMETERS FOR AUTOMATIZATION OF THE DETECTION OF SOME CYCLOTRON DEVICE MALFUNCTIONS. Sablin, N. I. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 24-37(1973). (In Russian).

The automation of the control systems for the detection of the malfunctioning of the following cyclotron systems was considered: high frequency generator, vacuum system, cooling system, and system of compensating devices. For formalization of the process of examination of the devices on the basis of functional circuits and the concept of functional dependence, logic models were constructed which could mathematically describe the properties of interest in the device examined. On the basis of the logic model, the corresponding minimum aggregates of the controlling parameters could be determined. (tr-auth)

**20572** AUTOMATIC CONTROL CIRCUIT FOR POINT COLLECTOR MOVEMENT ALONG THREE PERPENDICULAR AXES. Terent'ev, Yu. I. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 52-54(1973). (In Russian).

The operation of an automatic control circuit by point collector movement along three perpendicular axes is described. The cir-

cuit was designed for guaranteeing the indication of the mean density distribution of an electron beam and for recording the data obtained. The study showed that the circuit is reliable. (tr-auth)

**20573** ENERGY RELATION BETWEEN THE ROD ELECTROSTATIC GENERATOR AND THE DIELECTRIC TRANSPORTER ONE. Kalganov, A. F. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 66-69(1973). (In Russian).

The maximum current level in an electrostatic generator with transporter-conductors in the form of rods was calculated. The results are compared with the calculations of the maximum current level in electrostatic generators with transporter-dielectrics. (INIS)

**20574** COMPARISON OF EXPERIMENTAL AND DESIGN DATA OF THE SHORT CIRCUIT FOR A DISK ROD ELECTROSTATIC GENERATOR. Kalganov, A. F.; Podpletneva, E. A.; Sivkov, Yu. N. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 59-61(1973). (In Russian).

The results of the experimental determination of the characteristics of the short circuit of a one-disc electrostatic generator with double glass stators are reported. The data obtained are compared with calculated data. (INIS)

**20575** ROD ELECTROSTATIC GENERATOR OF A CYLINDRICAL CONFIGURATION. Kalganov, A. F.; Korzennikov, Yu. A.; Korostelev, A. F.; Unzhakov, G. V. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 70-75(1973). (In Russian).

The characteristics and electrical and mechanical parameters of a rotor electrostatic generator with cylindrical configuration and with rod transporters are described. The technology for the fabrication of the rotor and stator of the generator is briefly described. (INIS)

**20576** POSSIBILITY OF DEVELOPING ACCELERATING SYSTEMS WITH LARGE FLIGHT APERTURES FOR ELECTRON SYNCHROTRONS. Didenko, A. N.; Kaminskaya, R. G.; Fomenko, G. P.; Yushkov, Yu. G. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 76-80(1973). (In Russian).

Theoretical and experimental studies on the possibility of using segments of an iris waveguide with an open waveguide at the end as an accelerating system for a high-energy electron synchrotron are described. The effect of the open waveguide on the size of the shunt resistance of the iris waveguide is studied. It is shown that by use of the properties of the open waveguide an accelerating system requiring less power even during operation at a high multiplicity frequency can be produced. (INIS)

**20577** HIGH-FREQUENCY GENERATOR FOR EXPERIMENTS ON SHF FIELD FOCUSING EFFECT ON ELECTRON CAPTURE INTO ACCELERATION IN A BETATRON. Nepokrytykh, Yu. A.; Zelentsov, V. I. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 7-11(1973). (In Russian).

The characteristics are described and a block diagram given of the high frequency generator designed for experimental study of the process of supplementary focussing of electron beams with superhigh frequency fields during their capture in acceleration. The powerful magnetrons operating in a pulse regime are the basic elements of the generator. The magnetron has mechanical tuning in a wide range and can be tuned with great accuracy. By the use of this generator, resonators can be constructed with a large tolerance and without devices for frequency tuning. (INIS)

**20578** REACTION-FREE INTENSITY MEASUREMENT OF A PULSED ION BEAM. Reimann, R. (Schweizerisches Inst. fuer Nuklearforschung, Villigen). Z. Angew. Math. Phys.; 25: No. 1, 1-8(25 Jan 1974). (In German).

An apparatus is described which is designed for the reaction-free measurement of the intensity of a proton beam, pulsed at 50 MHz. It consists essentially of a coaxial resonator tuned to the pulse frequency of the beam. The ions flow through the resonator in the axial direction and excite the latter to oscillations in the TM-mode, so that the amplitude of the h.f. oscillations are a measure of the beam intensity. The theory of operation is explained with the aid of block diagrams and drawings of the apparatus. The method described has the advantage of greater sensitivity compared with other methods such as second harmonic detection, and the use of a current transformer and gated integrator. (INIS)

## Ion Sources and Injection and Extraction Systems

**20579** POSSIBILITY OF BETATRON CAPTURE INCREASE BY USING ADDITIONAL SHF FOCUSING FIELDS. Nepokrytykh, Yu. A.; Zelentsov, V. I. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 15-20(1973). (In Russian).

The effect of superhigh frequency fields on the process of electron capture in betatrons was experimentally studied. The experiments were made at injection currents from 30 to 150 mamp and electron energies from 20 to 50 keV during wide variation of the power supplied. The data obtained confirmed theoretical calculations on the possibility of increasing the particle capture coefficient in betatrons by using supplementary focussing superhigh frequency fields. (tr-auth)

## Ion Optics and Field Calculations

**20580** (ORNL-TM- 4746) SUPPRESSION OF RANDOM NOISE IN AVF CYCLOTRON MAGNETIC FIELD MEASUREMENTS. McNeilly, G. S. (Oak Ridge National Lab., Tenn. (USA)). Oct 1974. Contract W-7405-eng-26. 25p. Dep. NTIS $4.25.

A program—SMOOTH—has been written to minimize the effect of random fluctuations in magnetic field data measured in AVF cyclotrons. Although the code was written for the above applications, it could be used for smoothing any data set with periodic variation. (auth)

**20581** (UCID-16667) ELECTROMAGNETIC SELF-FORCES OF A CHARGED PARTICLE BEAM INTERACTING WITH A CYLINDRICAL CAVITY. Cooper, R. K.; Neil, V. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Jan 1975. Contract W-7405-eng-48. 9p. Dep. NTIS $4.00.

The accelerating structure is taken to be a series of cylindrical pill-box cavities of radius b and axial extent h. The longitudinal component of the electric self-field generated by a beam passing through one such box was investigated theoretically. In practice, there must be a hole in the box for the beam to pass through, but the presence of the hole is neglected. This approximation is discussed and justified. The electrostatic field arising from the charge in the beam is not treated. In practice, this field is primarily in the radial direction, terminating near the edge of the hole, and has no appreciable effect on the longitudinal motion of the particles. A beam length is treated sufficiently short that the beam passes through the box before any signal is reflected back to the beam from the outer wall at radius b. The beam length is sufficiently long that axial variations in the beam current within the axial extent, h, of the box may be neglected. These two conditions make possible the calculation presented. In the concluding section, the amount of energy radiated into the box is calculated by integrating the product of the beam current and the electric self-field over the time interval required for the beam to pass through the box. (WHK)

**20582** CHARGED PARTICLE BEAM FOCUSING WITH A BENDING MAGNET WITH PARALLEL INPUT AND OUTPUT BOUNDARIES. Kharitonenko, Yu. P.; Komov, A. I.; Pirogov, N. V. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 21-23(1973). (In Russian).

The parameters of a beam passing through a bending magnet with parallel input and output boundaries were calculated. It was assumed that the movement of the ions in the vertical plane of the magnet was not affected. Formulas were derived for the calculation of the elimination of the focal point of the bent beam. (tr-auth)

**20583** EXPERIMENTAL INVESTIGATION OF THE DISPERSION PROPERTIES OF A DOUBLE-ROW STEP SYSTEM IN A CIRCULAR WAVEGUIDE. Didenko, A. N.; Kaminskaya, R. G. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 87-91(1973). (In Russian).

The dispersion equations for the accelerating system of a cybernetic accelerator of the double-row step structure type in a circular waveguide are derived. The dispersion properties of a waveguide of this type were also determined experimentally. The existence of cophase symmetrical, cophase asymmetrical, antiphase symmetrical, and antiphase asymmetrical oscillation modes was established experimentally. The calculated and experimental dependences of the moderating ratio are reported for all oscillation modes. (INIS)

**20584** SOME RESULTS OF THE COMPARISON OF THE DISPERSION RELATIONS OBTAINED BY DIFFERENT METHODS WITH EXPERIMENTAL DATA. Chernogalova, L. F. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 205: 3-6 (1973). (In Russian).

Equations for the calculation of the dispersion properties of iris waveguides, obtained by different methods, are reported and briefly evaluated. The results of calculations made with the different equations were compared with experimental data. It was observed that the normal wave method and its different modifications can be used for studying the dispersion properties of wave-

guides with a rectangular cross section with a small number of irises along the wave. (INIS)

## Storage Rings

**20585** (BNL-19618) "SEPARATED FUNCTION" STORAGE RINGS (COMBINATION OF A MEDIUM CURRENT ACCELERATOR-STORAGE RING WITH A HIGH CURRENT DC STORAGE RING). van Steenbergen, A.; Month, M. (Brookhaven National Lab., Upton, N. Y. (USA)). Sep 1974. 12p. (TM-1501). Dep. NTIS $4.00.

The conceptual design of a medium current accelerator-storage ring combined with a high current dc storage ring is given. It provides for a direct accelerator with maximum radius within the FNAL boundary, with a peak proton beam energy for fixed target physics of (0.54 $\hat{B}$) TeV ($\hat{B}$ ≡ maximum dipole field value in Tesla). This accelerator is combined with a dc storage ring incorporating two 1 km long straight sections for single or multiple beam-beam interaction regions, with a maximum c-of-m pp energy of ~ (0.54 $\hat{B}$) TeV. (auth)

**20586** (LA-tr-74-35) STORAGE RINGS FOR BUNCHING AND DEBUNCHING BEAMS OF PARTICLES ACCELERATED BY A HIGH-CURRENT ACCELERATOR-MESON FACTORY. Batskikh, G. I.; Vasil'ev, A. A.; Meshcherov, R. A.; Murik, B. P. 1974. Translated by A. D. Cernicek from pp 249-253 of Trudy Tret'ego Vsesoiuznogo Soveshchaniia po Uskoriteliam Zariazhennykh Chastits, Nauka, Moscow, 1973. 7p. Dep. NTIS $4.00.

Different possibilities of adding storage rings to linac meson factories are discussed. A storage ring-buncher using single turn extraction of the stored proton bunch onto an external target permits the generation of neutron pulses having a duration of ~20 nsec, with a repetition frequency of 100 Hz and having a mean intensity of $\sim 1.5 \times 10^{16}$ neutrons/sec. These parameters, which exceed by almost two orders of magnitude the parameters of the most powerful existing pulsed neutron source (the electron accelerator ORELA), could be obtained at 0.6 GeV injection energy and the $H^-$ current projected for the accelerator to be developed in the USSR, using a $^{238}U$ target. Comparative parameters of the linear accelerator in Los Alamos (USA), and the proposed meson factory in the USSR, using a stretcher ring and buncher ring (MF-S and MF-B) are presented, as well as the characteristics of the resulting neutron sources. (WHK)

**20587** (RL-74-151) SOME NOTES ON THE SEPARATION OF $e^+$ $e^-$ BEAMS IN THE INTERACTION REGIONS. Harold, M. R. (Science Research Council, Chilton (UK). Rutherford Lab.). Nov 1974. 8p. (EPIC/MC-64). Dep. NTIS $4.00.

During the injection and acceleration of particles in EPIC, the electron and positron beams must be prevented from colliding. They will be separated by the use of electrostatic plates situated next to each high-$\beta$ doublet. The requirements are listed. Separated beam-beam dipole effects are considered. Conditions for electrostatic separation are discussed. (auth)

**20588** (RL-74-152) EPIC SEXTUPOLES: STATUS REPORT. Harold, M. R. (Science Research Council, Chilton (UK). Rutherford Lab.). Nov 1974. 24p. (EPIC/MC-65). Dep. NTIS $4.25.

In order to stabilize the beams in EPIC against the head-tail effect, the machine chromaticity $\xi$ $[(\Delta Q/Q)/(\Delta p/p)]$ must be altered from its natural large negative value to a slightly positive value. This is achieved by adding sextupoles to the lattice. These, however, introduce resonance forcing terms of second order in combination with $\alpha_p$, as well as third, fourth and higher order effects. With the present arrangement of sextupoles the second order effects do not appear too serious, and it has been found possible to reduce the third order terms to small values. The stable area is presently limited by fourth and higher order terms, the elimination of which represents a formidable task. This report summarizes the situation to date. (auth)

**20589** (RL-74-154) BRIEF SUMMARY OF BEAM LOADING EFFECTS EXPECTED IN EPIC. Donald, M. H. R. (Science Research Council, Chilton (UK). Rutherford Lab.). Nov 1974. 20p. (EPIC/MC-67). Dep. NTIS $4.00

It is shown that transient beam loading problems are inevitable in large electron-positron storage rings when the circulating bunches are widely spaced. Some of the results of calculations are shown, first concerning single transit effects, then resonant buildup effects due to multiple transits. The power requirements thus obtained are not as large as at first feared providing that the bunch length does not decrease from its natural size. Short range wake fields have been obtained which will prove useful in stability calculations and which may also help in determining the role of different bunch lengthening mechanisms. The results of calculations on multiturn effects show that severe problems may be encountered if it is not possible to tune away from high impedance resonances. (auth)

**20590** (UCID-15701) LIFETIME OF A CIRCULATING BEAM IN THE HIGH INTENSITY STORAGE RING. Lamb, W. A. S. (SEE CODE- 9500007 California Univ., Livermore (USA). Lawrence Radiation Lab.). 5 Aug 1970. 5p. Dep. NTIS $4.00.

The lifetime of a beam in the contemplated storage ring will ultimately be limited by the increase of betatron amplitude due to multiple coulomb scattering of the electrons on the residual gas. This is because of the comparatively low energy of the beam which makes nuclear interactions and diffraction scattering neglectable. (auth)

## Experimental Facilities

**20591** (BNL-19582) LOW MOMENTUM ANTIPROTON FLUX ENHANCEMENT IN THE LESB. Lovett, B.; Mishina, M.; Nakano, I.; Snyder, J.; Zeller, M. E.; Lazarus, D. (Brookhaven National Lab., Upton, N. Y. (USA)). 28 Dec 1974. 7p. Dep. NTIS $4.00.

The use of energy degraders to enhance the low momentum antiproton flux in the LESB has been studied. Degrading at the production target produced large flux increases below 600 MeV/c and extended the useful antiproton momentum range of the beam to below 450 MeV/c. (auth)

**20592** (CEA-N-1739) REALIZATION OF A TRITIUM-GAS TARGET DESIGNED FOR USE IN THE PRODUCTION OF NEUTRON FLUXES WITH A TANDEM VAN DE GRAAFF ACCELERATOR. Haouat, G.; Seguin, S. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Jul 1974. 16p. (In French). Dep. NTIS (US Sales Only) $4.00.

A tritium-gas target designed for use in the production of neutron fluxes is described. The neutrons are produced from the T(p,n) and T(d,n) reactions for fast neutron elastic and inelastic scattering experiments. The circulation of a cooling gas (helium) permits use of the gas cell with currents up to 3 or 4 $\mu$A. The principal advantages of this target are exceptional security against window rupture and a very weak production of parasitic neutron groups. (auth)

**20593** (COO-3521-132) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. Proposal 4. Cyclotron Facility: Production of Radionuclides, Labeled Compounds and Fast Neutron Beams. Progress Report, May 1, 1971-April 30, 1973. Laughlin, J. S.; Tilbury, R. S.; Kuo, T. Y. T. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). 1973. Contract AT(11-1)-3521. 29p. Dep. NTIS $4.50.

Research and development at the Sloan-Kettering cyclotron is outlined and the cyclotron use is summarized. The yields of radionuclides obtained for various target materials and bombarding particles are listed. The production of $^{13}N$-ammonia, $^{13}N$-glutamine, and $^{13}N$-glutamate is described. The production and chemical separation of selenium-73 is discussed. The use of $^{11}CN^-$ for blood labeling is described and results of the measurement of the excitation functions for the $^{20}Ne(d,^4He)^{18}F$ and $^{16}O(^3He,p)^{18}F$ reactions are reported. The production of carbon-11 labeled compounds is reviewed and neutron beam production at the cyclotron facility is briefly discussed. (WHK)

**20594** (JAERI-M-5768) USC-3 TERMINAL STATION SYSTEM PROGRAM. Tsugita, T. (Japan Atomic Energy Research Inst., Tokyo). Jul 1974. 46p. (In Japanese). Dep. NTIS (US Sales Only).

USC-3/TSSP-Terminal Station System Program-for USC-3 is described. The on-line system was developed to obtain quick processing of the data acquired with the LINAC. Mini-computer USC-3, used for data gathering, is employed as a remote batch terminal, which is connected to FACOM 230-60 in the Computing Center via the communication line. The hardware of the terminal, line control method, program structure of USC-3/TSSP, facilities for the system and the operation are explained. (auth)

**20595** (JAERI-M-5835) HIGH-SPEED TIME ANALYZER FOR THE LINAC. Kinbara, S.; Tawa, F. (Japan Atomic Energy Research Inst., Tokyo). Sep 1974. 102p. (In Japanese). Dep. NTIS (US Sales Only).

The high-speed time analyzer used for time-of-flight measurements at the linear accelerator, and the problems encountered in its construction are described. It has many functions as well as the high speed performance. As the principal element 74S type TTL logic is employed; which is incorporated in the 6 width NIM module. Features of the time analyzer are: the maximum number of channels, 65535; minimum channel width, 25 nsec (counter to counter, 2 nsec); the number of stop counter channels, 8; the number of buffer registers for the output data, 4; and the variable

width stop mode. The output of the time analyzer is connected to a USC-3 type computer system. (auth)

**20596** (JINR-1-7658) USING ACCELERATION AS A SPECTROMETER FOR LOW ENERGY PARTICLES. Vasilishin, B. V.; Giordehnesku, N.; Malashkevich, R. T.; Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 16p. (In Russian). INIS.

This study shows that the magnetic field of the OIYaI synchrophasotron can be used as a meson-particle spectrometer for measuring the probability of cumulative meson formation. (tr-SJR).

**20597** (JINR-1-8028) FACILITY FOR STUDY ON CUMULATIVE MESON PRODUCTION. Baldin, A. M.; Giordehnesku, N.; Zubarev, V. N.; Ivanova, L. K.; Kirillov, A. D.; Kotov, V. I.; Moroz, N. S.; Nezhdanova, S. A.; Povtoreko, A. A.; Radomanov, V. B.; Rogal, A. D.; Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 12p. (In Russian). INIS.

A unit is described for measuring energy spectra of mesons at an angle of 180°, which are generated on nuclei by accelerated nucleons. The intensity of the proton beam extracted from the OIYaI synchrophasotron was monitored by a scintillation counter telescope. In order to determine and control the beam position during target irradiation a full-absorption Cherenkov counter was used. Features of the formation channel and beam transport are described. (tr-SJR).

**20598** (LNF-74/32(R)) INSTRUMENTAL ASPECTS OF A SYNCHROTRON RADIATION FACILITY. Balzarotti, A.; Bianconi, A.; Burattini, E.; Piacentini, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 12 Jun 1974. 26p. Dep. NTIS (US Sales Only) $4.50.

The technical problems encountered in the design of an experimental facility for synchrotron radiation are described. Certain aspects discussed are often overlooked or not adequately treated in the literature. The optical properties of some focusing mirrors are also illustrated in detail and the solutions adopted at the Frascati's facility are discussed. (auth)

**20599** (LNF-74/33(P)) THERMAL BEHAVIOR OF A BREMSSTRAHLUNG RADIATOR. Barbini, R.; Guaraldo, C.; Scrimaglio, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 21 Jun 1974. 18p. Dep. NTIS (US Sales Only) $4.00.

Medium energy pion beams can be obtained by electron linear accelerators in a two steps process, consisting in the production of a bremsstrahlung gamma ray beam followed by the subsequent photoproductions of pions. The two processes can either be made to occur in the same target or in two separate targets, i.e., the radiator and the pion source, as is the case of the geometry adopted at the Leale Laboratory at Frascati. The radiator and pion source are 35 cm apart, and a magnet placed between them sweeps away electrons which could contribute to the contamination of the $\pi$-beam. High-density materials with low A and low Z numbers are generally choosen as pion sources, since photoproduction is a surface phenomenon which shows an $A^{\frac{1}{3}}$ dependence so that the yield will vary as $A^{-\frac{1}{3}}$. A carbon target is preferred since it allows for rather similar yields of positive and negative pions. On the other hand, high Z materials must be choosen as radiators, in order to enhance the bremsstrahlung yield. Moreover, due to the small electron beam cross section, a large amount of power impinges on a restricted area of the radiator and can result in a local or general melting of it. Therefore, high melting point and good thermal conductivity place a further constraint on the selection of suitable materials. The temperature field established by the primary electron beam was studied throughout the radiator, for various dimesions, thicknesses and materials in order to find criteria for the choice of the material and for possible cooling of it. (WHK)

**20600** (RL-74-147) RESEARCH AND DEVELOPMENT FOR POLARIZED TARGETS (1973/74). Cox, S. F. J. (Science Research Council, Chilton (UK). Rutherford Lab.). Sep 1974. 19p. Dep. NTIS (US Sales Only) $4.00.

A helium-3 refrigerator has been refurbished and ancillary equipment assembled to provide a research and development facility for future polarized targets. Small sample polarization tests and relaxation time measurements have been performed on material prepared for the $\pi$9 Frozen Spin Target. The first stage in the development of material for the Polarized Deuteron Target has been completed. (auth)

**20601** IMPROVEMENT IN PROTON IRRADIATION TECHNIQUE FOR STUDIES IN RADIATION CHEMISTRY. Eremin, L. P.; Oblivantsev, A. N. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 55-56(1973). (In Russian).

The operating principles and characteristics of a remote-controlled installation for experiments on the irradiation of ionic salts with cyclotron proton beams were described. The installation was designed for rapid transfer of the irradiated sample into a solvent where it is rapidly cooled and dissolved, which prevents post-irradiation annealing. The installation was used in cyclotron irradiation experiments in the temperature range from 25 to 300°C. (tr-auth)

**20602** NEUTRON IRRADIATION DEVICE WITH PHILIPS PW 5320/01 GENERATOR. Vognar, M.; Matejka, K. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 97-106(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The irradiation device with the Philips PW 5320/01 neutron generator is described. It makes possible work in the field of neutron radiography, measurement of effective cross-sections of materials for 14 MeV neutrons, speedy activation analysis, etc. The design of the generator, the shielding, and the measuring apparatus for neutron radiography is described. Estimated values of neutron flux in a polyethylene moderator and in the vertical channel of the irradiation device are reported. (auth)

# PHYSICS (ASTROPHYSICS AND COSMOLOGY)

**20603** SPACE RESEARCH XIV. Proceedings of the Sixteenth Plenary Meeting of COSPAR, Constance, Germany, May 23–June 5, 1973 and Symposium on Noctilucent Clouds and Interplanetary Duct, Constance, Germany, May 24–25, 1973. Rycroft, M. J.; Reasenberg, R. D. (eds.). Berlin; Akademie-Verlag (1974). 815p. (CONF-7305109-; CONF-7305110-). 160. M.

Topics covered include: satellite geodesy; the Earth's neutral atmosphere; the ionosphere; the magnetosphere; the Sun; ultraviolet astronomy; the moon; and the composition of Venus. There are review articles on satellite beacon measurements, properties of cosmic x-ray sources, and cometary physics and chemistry. Summaries of papers presented at the symposium on noctilucent clouds and interplanetary dust are included. (WDM)

## Cosmic Radiation

*Refer also to abstracts 19704, 19715, 19740, 19744–19749, 20739, 20755, 20907–20909, 20912–20916, 20918, 20921, 20926, 20929, 20930, 20944, 20946, 20947, 21014, 21016, 21017, and 21058.*

**20604** CELESTIAL DISTRIBUTION OF GALACTIC GAMMA RADIATION. Schlickeiser, R.; Thielheim, K. O. (Univ., Kiel). Astron. Astrophys.; 34: No. 1, 167-169(Aug 1974).

The celestial distribution of gamma-ray intensity is calculated on the basis of relationships between interstellar hydrogen and cosmic-ray gas densities and the strength of the interstellar magnetic field for which a model is being used. Results are compared with empirical data from the OSO-3 experiment of Kraushaar et al. (1972) and discussed with respect to equilibrium conditions of the galactic disk. (auth)

**20605** SEARCH FOR OPTICAL EMISSION FROM COSMIC GAMMA–RAY BURSTS. Grindlay, J.E.; Wright, E.L.; McCrosky, R.E. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). Astrophys. J. Lett. 192: No. 3, L113-L114 (15 Sept 1974).

Long–exposure films are available for both times and regions of sky for several cosmic $\gamma$–ray bursts. An upper limit of $m_v > 6$ was set for optical emission from the well–observed 1972 May 14 event. The corresponding lower limit for the ratio of X–ray to optical energy flux in the burst is $F_x/F_{opt} > 100$. This may restrict solar–flare analogy models for the burst sources. (auth)

**20606** CORRELATION OF COSMIC-RAY COUNTS AT BALLOON ALTITUDES ON 100 ms TIME SCALE. Cavani, C. (CNR, Bologna); Frontera, F.; Fuligni, F.; Galli, M. Lett. Nuovo Cim.; 11: No. 16, 673-675(21 Dec 1974).

An attempt was made to measure the correlation of a series of single events randomly distributed in time and widely spaced with respect to the sampling interval chosen. As a source of these events, counts due to the passage of cosmic-ray charged particles through a balloon-born plastic scintillator were used. A strong deviation from what would be expected from completely random data was found in the autocorrelation coefficients plotted versus time lags. (JFP)

**20607** $^{26}$Al IN CHONDRITES WITH A LOW RADIATION AGE. Alekseev, V. A.; Ustinova, G. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Meteoritika; No. 33, 49-50(1974). (In Russian).

**20608** INTERPRETATION OF THE CHEMICAL COMPOSITION OF VERY HIGH-ENERGY COSMIC RAYS. Cesarsky, C. J.; Audouze, J. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 30: No. 1, 119-126(Jan 1974).

The presently available data on the chemical composition of the high-energy cosmic rays have been analyzed in the frame of the most widely used theory of cosmic-ray propagation. It appears from this analysis that (1) the mean path length of the cosmic rays in the Galaxy decreases when the energy increases, (2) the sources of high-energy cosmic rays are richer in Fe relatively to the M(C + O) elements than the sources of lower energy cosmic rays. Other hypotheses on the sources of cosmic rays are also discussed. The dependence of the mean path length on the helium content of the interstellar gas is studied. The effects of a possible variation of the nuclear cross sections with the energy are considered. (auth)

## Stars

*Refer also to abstracts 20704, 20708, 20770, 20775, and 20776.*

**20609** DIFFUSION PROCESSES IN THE ENVELOPES OF MAIN-SEQUENCE A STARS: MODEL VARIATIONS DUE TO HELIUM DEPLETION. Vauclair, G. (Observatoire de Meudon, France); Vauclair, S.; Pamjatnikh, A. Astron. Astrophys.; 31: No. 1, 63-70(Feb 1974).

Diffusion of helium is computed in the subphotospheric radiative part of the envelopes of 2 $M_\odot$ and 1.5 $M_\odot$ Population I Stars. The influence of the helium abundance variation on the structure of the envelopes is taken into account along the computations. The helium abundance is reduced from Y = 0.28 to Y = 0.10 in the outer convective zones, on a time scale of $1.5 \times 10^8$ years and $1.0 \times 10^8$ years for 1.5 $M_\odot$ and 2 $M_\odot$ respectively. At this time, the He II convective zone disappears. Diffusion processes, which first take place at the bottom of the He II convective zone (the two convective zones being linked by overshooting), then proceed at the bottom of the H + He I convective zone, where diffusion time scales are much smaller ($\sim 10^3$ years). Consequences of these computations on the interpretation of peculiar A stars, Am stars and on the variability of $\delta$ Scuti stars are discussed. (auth)

**20610** HEAVY METALS IN M-GIANTS. Huggins, P. J. (Univ. of Cambridge, Eng.). Astron. Astrophys.; 31: No. 1, 103-107(Feb 1974).

In view of the importance of heavy metal abundances in evolved stars as monitors of internal nucleosynthesis and subsequent mixing processes, a reanalysis is made of data presented for the M 2-giant star $\beta$ Peg by Yamashita (1965), who found its rare earth elements to be considerably enhanced. The analysis is performed differentially with respect to the K 2-giant $\alpha$ Boo, and the abundance ratios of Nd, Sm, Ce, Gd, to Ti are determined by comparing relative shifts of empirical curves of growth with those computed from appropriate model atmospheres. The large over-abundance of heavy metals found by Yamashita is not confirmed, and the implications of this result for other cool stars are discussed. (auth)

**20611** NEUTRON STARS IN SUPERNOVA REMNANTS. Amnuel, P. R.; Guseinov, O. H. (Shemacha Astrophysical Observatory, USSR). Astron. Astrophys.; 31: No. 1, 37-40(Feb 1974).

Data on supernova remnants is analyzed in view of a search for black holes. For the remnant synchrotron radiation to be maintained, the magnetic field in the remnant should change as $\sim R^{-(1.2 \text{ to } 1.5)}$. Continuous injection of relativistic particles is shown to be necessary. The energetics of the remnants, the increase of magnetic flux, and data about the directions of the magnetic fields are discussed with the assumption that, in each remnant, there is a neutron star (pulsar). The remnants with black holes do not radiate in the radio. The search for black holes is more promising for binary systems. (auth)

**20612** SPECTROSCOPIC STUDY OF THE BLUE HALO SILICON STAR HD 97859. Stalio, R. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys.; 31: No. 1, 89-95(Feb 1974).

A study of the atmosphere of the high-latitude blue star HD 97859 was carried out using spectrograms at 12.4 Å/mm. The results obtained are the following: a) HD 97859 is probably a field horizontal-branch star with peculiarities characteristic of Ap Si-4200; the spectral type indicated by the color is B5, b) the atmosphere seems to have a number of areas of enhanced silicon, helium, and magnesium. The rotation of the star gives rise to well-marked variations of radial velocities and equivalent widths of the metallic lines. c) Several spectrograms present evidence of Fe I lines and of strong unidentified lines. (auth)

**20613** SPECTROSCOPIC STUDY OF LY AURIGAE. Andersen, J. (Copenhagen Univ. Observatory); Batten, A. H.; Hilditch, R. W. Astron. Astrophys.; 31: No. 1, 1-4(Feb 1974).

Radial velocities derived from 44 spectrograms were analyzed to derive new elements for LY Aurigae. These elements were: $K_1 = 113.0$ km s$^{-1}$, $K_2 = 301.4$ km s$^{-1}$, $V_0 = -2.6$ km s$^{-1}$, $e = 0.0$. Using the light curve solution of McCluskey and Kondo (1973) physical parameters were derived for the system: these show that it is a normal semi-detached system which has undergone case A mass-exchange. (auth)

**20614** LOW-VELOCITY RED DWARFS IN THE VICINITY OF THE NORTH GALACTIC POLE. Gliese, W. (Astronomisches Rechen-Institut, Heidelberg). Astron. Astrophys.; 34: No. 1, 147-148(Aug 1974).

Distances and upper limits for transverse velocities derived from Pesch's data (1972) for a sample of low-velocity red dwarfs are compared with the data of the McCormick stars (Vyssotsky et al., 1943, 1946, 1952, 1956). There is a discrepancy of velocity dispersions still unexplained. (auth)

**20615** RADII OF THE AP STARS. Stift, M. J. (Dunsink Observatory, Dublin). Astron. Astrophys.; 34: No. 1, 153-155(Aug 1974).

The radii of 35 magnetic and other peculiar A- and B-type stars were calculated with the help of luminosities and effective temperatures derived for individual stars. The results contradict the concept of a constant radius for all Ap stars. (auth)

**20616** PHOTOELECTRIC MEASUREMENTS OF SIRIUS B IN UBV AND STROEMGREN SYSTEM. Rakos, K. D. (Univ., Vienna). Astron. Astrophys.; 34: No. 1, 157-158(Aug 1974).

Area scanner photoelectric measurements of Sirius B are presented. The final values are: $V = 8.08$; $(U-B) = -0.84$; $(B-V) = -0.28$; $M_v = 10.83$; $(b-y) = -0.19$; $(u-b) = -0.32$; $m_1 = 0.24$; $c_1 = -0.42$. The white-dwarf stage of Sirius B is probably less than two thousand years old. (auth)

**20617** CALCULATION OF INFRARED SPECTRA FROM DUST IN PLANETARY NEBULAE. Bussoletti, E.; Epchtein, N.; Baluteau, J. P. (Observatory, Meudon, France). Astron. Astrophys.; 34: No. 1, 141-146(Aug 1974).

Grain equilibrium temperatures and the infrared continuum for several planetary nebulae were calculated; the heat balance equation was handled rigorously. The dust grains were taken to be either graphite, or ice covered graphite cores. The dust was taken to be either in: (1) the outer H I region, or (2) the H II region. Comparison with observation suggests that a combination of these two cases would be more realistic. A small fraction ($10^{-4}$ to $10^{-5}$) of the resonantly trapped Ly $\alpha$ radiation in the H II region is absorbed by grains situated there, and gives rise to the observed ir excesses between 4 $\mu$ and 12 $\mu$. The remaining part of Ly $\alpha$ is absorbed by the colder grains lying in the outer H I region and may explain the ir fluxes observed beyond 15 $\mu$. (auth)

**20618** METAL CONTENT AND MICROTURBULENCE IN G8-K3 GIANTS, AS INVESTIGATED BY MEANS OF PHOTOELECTRIC PHOTOMETRY IN VERY NARROW BANDS. Gustafsson, B. (Univ. of Uppsala); Kjaergaard, P.; Andersen, S. Astron. Astrophys.; 34: No. 1, 99-128(Aug 1974).

The strength of a narrow group of weak metal lines was measured, by means of an echelle spectrometer, in the spectra of 80 G and K giants. For more than half of the stars, the strength of another group with lines on the flat part of the curve of growth was also measured. The narrow-band indices were analyzed as a function of the fundamental atmospheric parameters by means of scaled solar model atmospheres. The temperature scale was established with the aid of a new theoretical calibration of R-I. The accelerations of gravity were estimated from absolute magnitudes and evolutionary tracks. The effects of systematic errors in the analysis were studied extensively. Possible errors due to erroneous and incomplete physical data and to too schematical model atmospheres, due to the LTE assumption, etc., were investigated. (WDM)

**20619** Y CAM: AN ECLIPSING SYSTEM WITH A DELTA SCUTI PRIMARY. Broglia, P.; Marin, F. (Astronomical Observatory, Milan). Astron. Astrophys.; 34: No. 1, 89-97(Aug 1974).

Photoelectric light curves of the eclipsing variable Y Cam in the B and V wavelength regions are presented. The orbital period is studied using all available epochs of primary minimum and the variability of the period is confirmed. The primary, larger and brighter component turns out to be a $\delta$ Sct star with a one and a half hour period and a variable light amplitude. The amplitude variation moreover is not correlated with the phase in the orbital motion. One can conclude therefore that the amplitude variations in $\delta$ Sct stars are not necessarily caused by a companion. Direct photometric solutions are computed and then improved by means of the Irwin method. (auth)

**20620** LIGHT-CURVE SYNTHESIS AND ELEMENT DETERMINATION FOR ECLIPSING BINARIES. Application to MR Cyg. Soederhjelm, S. (Lund Observatory, Sweden). Astron. Astrophys.; 34: No. 1, 59-68(Aug 1974).

A practicable scheme for calculating theoretical light-curves for moderately close eclipsing binaries, according to Kopal's analytical theory, is presented. The necessary "$\alpha$-functions and related integrals" are shown to be obtainable from straightforward formulae. The reflection effect is treated to sufficient approximation, and care is taken in specifying the fraction of reflected light eclipsed. Comparisons to results by purely numerical computer-models indicate that the accuracy of the present approach is better than 0.01 light-units for fractional radii of about 0.30 to 0.35 (and presumably much better for small radii). The fundamental elements are determined by differential corrections and least squares. Application to MR Cyg shows that the method converges satisfactorily, even though the differential coefficients used are only approximate. A final comparison of this and other studies of MR Cyg shows that the Russell-Merrill method of solution (with rectification) gives results that deviate systematically from more direct "computer studies." (auth)

**20621** AP STAR 108 AQR I. Megessier, C. (Observatory, Paris). Astron. Astrophys.; 34: No. 1, 53-58(Aug 1974).

Photometric and spectroscopic observations of the ApSi 4200 star 108 Aqr confirm the periodic variations with a period of 3.73 days found by Morrisson and Wolff (1971). The spectral type of this star is determined as B5V or B6V. The effective temperature is 14,000°K ($\theta_e = 0.36$) and the surface gravity, constant throughout the periodic variations, is $\log g = 3.5$, which corresponds to the gravity of a dwarf for the method used. It is shown that effective temperature's variations cannot account for those of color index. Profile variations for the Ti II, Sr II, Fe II, Cr II lines can be seen on the microphotometer tracings. It is found that the mean radial velocity was 19.8 km $s^{-1}$. The Si II do not show velocity variations, while the radial velocities of the Fe II and Cr II lines vary slightly and those of the Ti II lines clearly show variations. Also one can measure the radial velocities of the red and violet components of the Ti II lines when they show signs of doubling. It is shown that a binary system cannot account for the observed variations (light, line profiles, and radial velocity). (auth)

**20622** DIGITAL ANALYSIS OF THE POLARIZATION WITHIN THE SERPENS NEBULA. Worden, S. P.; Grasdalen, G. L. (Kitt Peak National Observatory, Tucson, AZ). Astron. Astrophys.; 34: No. 1, 37-40(Aug 1974).

Photographic linear polarization data was digitally analyzed to determine the illuminating source for the Serpens Nebula ($\alpha_{1950} = 18^h27^m24.5^s$, $\delta_{1950} = +01°12'40''$). The results were two-dimensionally Fourier filtered to reduce noise. Some improvement in the data was produced in this manner. The result of this procedure indicates that the Serpens Nebula is a reflection nebula illuminated by an imbedded star and not by a nearby infrared source as suggested by Strom et al. (1974b). This illuminating star is probably a young zero age main-sequence star of spectral Type B 5-A 5. (auth)

**20623** WOLF-RAYET STAR HDE 311884 IN THE OPEN CLUSTER HOGG 15. Moffat, A. F. J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 34: No. 1, 29-32(Aug 1974).

Photoelectric UBV data for Hogg 15 yield: reddening $E_v = 1.16$, distance $= 4.2 \pm 0.4$ kpc, and age $\lesssim 8 \cdot 10^6$ years. Hogg 15 is therefore one of the few clusters known to lie in the inner arm -II. The WN 6 star HDE 311884 is a likely member with $M_v = -5.9 \pm 0.2$. (auth)

**20624** MORPHOLOGICAL STUDY OF THE PLANETARY NEBULA NGC 7662. Louise, R. (Observatory, Marseille). Astron. Astrophys.; 34: No. 1, 21-22(Aug 1974).

The planetary nebula NGC 7662 was photographed through narrow interference filters centered on H$\alpha$, [N II], and [O II] lines. A symmetrical form in H$\alpha$ and [O II] can be seen while the [N II] image has an irregular form. (auth)

**20625** DETECTABILITY OF Bp-TYPE ABUNDANCE ANOMALIES IN EARLY MAIN-SEQUENCE STARS. Baschek, B.; Kodaira, K.; Scholz, M. (Univ., Heidelberg). Astron. Astrophys.; 34: No. 1, 1-7(Aug 1974).

With model atmosphere techniques, selected spectral features in near-main-sequence stars were calculated in the range from O 9 to B 5 using anomalous element abundances which are typically found in middle to late Bp type stars. Whether these abundance anomalies can be detected at classification dispersion in stars earlier than about B 3 is discussed. The observed absence of weak-helium-line stars of the Si- and the P-Ga-type implies the absence of anomalies of these groups in early B stars. Anomalies typical of weak-helium-line stars of the Ti-Sr-type and of manganese stars may escape detection in classification work. (auth)

**20626** THREE-COLOR BEHAVIOR OF V 1057 CYG AFTER ITS OUTBURST. Giesekin, F. (Univ., Bonn). Astron. Astrophys.; 31: No. 1, 117-119(Feb 1974).

Three-color measurements of the peculiar variable V 1057 Cyg after its outburst, derived by means of photographic photometry, are discussed. The resultant three-color behavior of V 1057 Cyg is compared with the corresponding observed changes of spectral type. (auth)

**20627** UNUSUAL STRENGTH OF THE LINES OF Cr I AND Fe I IN THE A 2 p STAR HD 110066. Selvelli, P. L. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys.; 31: No. 1, 113-116(Feb 1974).

A direct comparison between the equivalent widths of the Ap star HD 110066 and the Sun was made in order to show the high intensity of these lines. The Cr I lines are systematically stronger

than those in the solar spectrum while the Fe I lines are, on the average, slightly weaker. These facts suggest a great overabundance of these elements. (auth)

**20628** PLANETARY NEBULAE WITH MULTIPLE SHELLS. Kaler, J. B. (Univ. of Illinois Observatory, Urbana). Astron. J.; 79: No. 5, 594-596(May 1974).

It is shown that the central stars of planetary nebulae with giant halos (ratio of outer to inner radius > 5) are much cooler than are those of nebulae which consist of double shells with a radius ratio ~2. For double shell nebulae, the change of ratio as a function of radius is consistent with the ejection of shells at different times; the inner shell is produced when the outer has a radius of about 0.10 pc. The giant halo and bright double shell nebulae occur for radii at which the inner nebula is becoming optically thin, and the central star is near its maximum luminosity. It appears that all of Hromov and Kohoutek's (1968) Type 1 nebulae, and perhaps (1/3) of all planetaries, possess double shells. Large halos appear around NGC 7009 and 7662, which make these examples of triple shell planetaries. (auth)

**20629** SPACE DISTRIBUTION AND RADIAL VELOCITIES OF SOME EARLY-TYPE STARS IN THE PERSEUS SPIRAL ARM. McCuskey, S. W.; Pesch, P.; Snyder, G. A. (Case Western Univ., Cleveland). Astron. J.; 79: No. 5, 597-602(May 1974).

Distances for 73 early-type stars and radial velocities for 43 of them have been determined in the region LF5 (l = 129°, b = −2°). Most of these stars are of luminosity classes III and V, and are shown to be at distances such that they fall within the stellar grouping commonly called the Perseus spiral arm. The analysis indicates that (1) The average radial velocity relative to the LSR of these stars is −40 km $sec^{-1}$. This result is in excellent agreement with the average velocities of both early- and late-type supergiants in the same region; (2)The stellar radial velocities are, on the average, about 10 km $sec^{-1}$ more negative over the distance range 1 to 3 kpc than predicted on the basis of the Schmidt model (1965); and (3) The average stellar radial velocity is about 10 km $sec^{-1}$ more positive than the average velocity of the neutral hydrogen concentration usually ascribed to the Perseus complex. (auth)

**20630** "HYADES ANOMALY" AND THE uvby LUMINOSITY CALIBRATION. Barry, D. C. (Univ. of Southern California, Los Angeles). Astron. J.; 79: No. 5, 616-622(May 1974).

Empirical evidence is presented that the b-y index is about half as sensitive to blanketing as the $m_1$ index for middle F through early G dwarfs. The appropriate blanketing correction to b-y removes the excess of the Hyades anomaly in the $c_1$, b-y plane over that in the $c_1$, $\beta$ plane. The mean quantities $\delta[c_1]$ and $\delta[m_1]$ for five open cluster late F through early G main sequences are found to be correlated with a slope $\Delta c_1/\Delta m_1 \approx 2.3$. Analysis of a group of field stars with parallax errors less than 10% indicates that the $c_1$ blanketing dependence increases from zero in mildly metal-poor stars ($\delta m_1 \gtrsim 0.05$) to $\Delta c_1/\Delta m_1 \approx 2.7$ for metal-rich stars ($\delta m_1 \approx 0.00$). Application of the field star dependence of $c_1$ on $m_1$ to the clusters removes the Hyades anomaly and establishes the mean cluster main sequence 0.24 mag more luminous than Blaauw's (1963) ZAMS at $\beta = 2.60$. It is 0.42 mag more luminous if the Lutz-Kelker (1973) corrections are applied. Empirical and theoretical arguments are presented supporting the conclusions that (1) the Hyades anomaly is primarily a blanketing phenomenon, and (2) the open cluster main sequences do not differ in luminosity by more than a few tenths of a magnitude. These small luminosity differences are explained by the observed differences in metallicity. (auth)

**20631** FOUR-COLOR AND Hβ PHOTOMETRY FOR OPEN CLUSTERS. IX. NGC 6871. Crawford, D. L. (Kitt Peak National Observatory, Tucson, AZ); Barnes, J. V.; Warren, W. H. Jr. Astron. J.; 79: No. 5, 623-625(May 1974).

Data for 24 stars that are members of the cluster yield a distance modulus of $V_0 - M_v = 11.5$. The average color excess is E(b-y) = 0.38. The x-ray source Cyg X-1, which is near NGC 6871 in the sky, is probably well beyond the cluster in distance from the Sun. (auth)

**20632** RADIAL VELOCITY OF DELTA DELPHINI. Leung, K. C. (Univ. of Nebraska, Lincoln). Astron. J.; 79: No. 5, 626(May 1974).

δ Delphini was observed on seven nights with the 72-in. telescope at a dispersion of 15 Å/mm. The amplitude of the radial velocity curve is about 4 km/sec, and none of the spectra show double lines. (auth)

**20633** INSTABILITY STRIP OF POPULATION II CEPHEIDS. Demers, S. (Laurentian Univ., Sudbury, Ont.); Harris, W. E. Astron. J.; 79: No. 5, 627-630(May 1974).

The position of the instability strip of Population II Cepheids in the H-R diagram is established. The results are based on the absolute magnitudes and intrinsic colors of 25 Population II Cepheids in globular clusters and 11 field variables. The absolute magnitudes of the field variables are obtained from a newly derived P-L relation and their color excesses are determined from U, B, V photometry and the cosecant reddening law. Population II Cepheids define an instability strip three times wider than the strip of classical Cepheids. In addition, the variables form two luminosity groups within the strip; this is due to the lack of Population II Cepheids with periods between 3.0 and 6.0 days. Compared with theoretical models, the position of the blue edge of the strip indicates that the helium content of Population II Cepheids is $Y \propto 0.3$. (auth)

**20634** RELATION BETWEEN CARBON STAR SPECTRAL TYPES AND COLORS. Honeycutt, R. K.; Faye, T. D. Jr.; Warren, W. H. Jr. (Indiana Univ., Bloomington). Astron. J.; 79: No. 5, 631-633(May 1974).

Observations of the [0.57]-[0.68]-μ (RED) colors of 32 carbon stars are reported and carbon star RED colors and Yamashita spectral classes are compared. The carbon stars are divided into three groups according to their [3.5]-[11.0]-μ (IR) colors. Group I has IR < 0.7, group II has 0.7 ≤ IR ≤ 1.1, and group III has IR > 1.1. RED colors and Yamashita spectral classes of group I stars correlate significantly, but RED colors and Yamashita types of groups II and III correlate less well. It is concluded that groups I-III are arranged on a decreasing boundary temperature sequence. The conclusion applies to those stars having Ca II λ8550 lines sensitive to the boundary temperature, and Yamashita spectral class lines sensitive to the photospheric temperature. (auth)

**20635** SCANNER OBSERVATIONS OF CARBON STARS FROM 5000 TO 7000 A. Faye, T. D. Jr.; Warren, W. H. Jr.; Johnson, H. R.; Honeycutt, R. K. (Univ., Indiana, Bloomington). Astron. J.; 79: No. 5, 634-641(May 1974).

Photoelectric spectrum scans at 20-Å resolution of 26 N-type and 11 R-type carbon stars from 5000 to 7000 Å are reduced to flux and presented in graphic form. A monochromatic color index [0.57]-[0.68] for this spectral region is defined and correlated with (V-R) and [3.5]-[11.0] color indices. New photometric indices are devised to measure CN and $C_2$ band strengths. The use of the CN indices provides a new photometric estimate of the $^{12}C/^{13}C$ ratio. The 0.56-μ $C_2$ index correlates positively with the 1-μ CN index and anticorrelates with the 2.3-μ CO index for a wide variety of carbon stars. Comparison of these correlations with predictions of molecular column densities from model atmospheres indicates that these interrelations can be understood as a variation of C/O among carbon stars. (auth)

**20636** NARROW-BAND HYDROGEN LINE PHOTOMETRY OF THREE EARLY-TYPE ECLIPSING BINARY SYSTEMS. Olson, E. C. (Univ. of Illinois, Urbana); Weis, E. W. Astron. J.; 79: No. 5, 642-648(May 1974).

Narrow-band Hγ photoelectric photometry was used to explore the radiative interaction as a function of phase in Z Vul, and to detail anomalies due to circumstellar contamination in AI Dra and RZ Cas. (auth)

**20637** OBSERVATION OF A LUNAR OCCULTATION OF DELTA GEMINORUM. Tremaine, S. D.; Groth, E. J.; Nelson, M. R. (Princeton, Univ., NJ). Astron. J.; 79: No. 5, 649-650 (May 1974).

Observation of a lunar occultation of δ Gem A shows that the absolute magnitude of any secondary component is $< M_v = 4.7$ if its separation from the primary along position angle 315° was < 0.017" at the time of the occultation. This result is consistent with recent evidence that δ Gem A is not a spectroscopic binary. (auth)

**20638** PARALLAXES OF FAINT DWARF MEMBERS OF THE HYADES CLUSTER. Upgren, A. R. (Wesleyan Univ., Middletown, CT). Astron. J.; 79: No. 5, 651-652(May 1974).

Parallaxes and proper motions have been obtained for faint red dwarfs in seven fields in the Hyades cluster region which have previously been found to have a high probability of membership, but have no other parallax determination. The weighted mean yields an absolute parallax of 0.0219 ± 0.0018 and a distance modulus of 3.29 ± 0.18. This result is close to the mean of all earlier parallaxes and substantially increases the total number now known, especially among the stars of the lower main sequence. Increased stability is likely through the use in each field of many faint reference stars with negligible proper motion. (auth)

**20639** NEUTRAL CURRENTS AND SUPERNOVAS. Schramm, D.N. (Fermi Institute, University of Chicago, Chicago, Illinois 60637); Arnett, W.D. Phys. Rev. Lett. 34: No. 2, 113-116 (13 Jan 1975).

It is shown that if more accurate neutrino opacities (including effects of electron degeneracy) are used in a gravitational collapse calculation, then the effects of neutral currents and coherent scattering may be considerably greater than was previously thought. It is also shown that a careful inclusion of the electron–capture neutrinos should increase the importance of the region near densities of $\sim 2\times 10^{11}$ g/cm$^3$. (auth)

**20640** THE UNUSUAL HORIZONTAL BRANCH OF NGC 2808. Harris, W.E. (David Dunlap Observatory, Richmond Hill, Ontario, Canada). Astrophys. J. Lett. 192: No. 3, L161-L163 (15 Sept 1974).

A new color–magnitude diagram for the southern globular cluster NGC 2808 shows a peculiar "split" horizontal branch: both red and extremely blue HB stars are present, but a large unpopulated gap exists between them in the color range $-0.1 < (B-V)_0 < 0.4$. The cluster's giant–branch morphology and red HB are normal for a moderately high–metallicity object, but the presence of the extremely blue $[(B-V)_0 < -0.1]$ HB stars is anomalous. This feature is interpreted as due to a possible discontinuous mass distribution along the horizontal branch. (auth)

**20641** BLACK–HOLE–NEUTRON–STAR COLLISIONS. Lattimer, J.M.; Schramm, D.N. (Departments of Astronomy and Physics, The University of Texas at Austin). Astrophys. J. Lett. 192: No. 3, L145-L147 (15 Sept 1974).

The tidal breakup of a neutron star near a black hole is examined. A simple model for the interaction is calculated, and the results show that the amount of neutron–star material ejected into the interstellar medium may be significant. Using reasonable stellar statistics, the estimated quantity of ejected material is found to be roughly comparable to the abundance of $r$–process material. (auth)

**20642** CAN A NEUTRON STAR BE COMPRESSED INTO A BLACK HOLE? Hwang, A. E. (Bell Laboratories, Murray Hill, New Jersey); Dykla, J. J. (Astrophys. J. Lett. 192: No. 3, L141-L143 (15 Sept 1974).

Models of geodesic accretion in general relativity indicate that the accreting matter would be unlikely to induce collapse of a neutron star into a black hole in a time less than the age of the Universe. It is suggested that the compression shock waves which appear to be a characteristic feature of nongeodesic accretion may compress a neutron star into a black hole in an astrophysically interesting, and indeed observable, time of the order of seconds. (auth)

**20643** DQ HERCULIS: WEAK SISTER TO Hz HERCULIS. Lamb, D.Q. (Department of Physics, University of Illinois, Urbana). Astrophys. J. Lett. 192: No. 3, L129-L133 (15 Sept 1974).

We have explored a model for DQ Her in which a strongly magnetic degenerate dwarf accretes matter from its companion in a close binary system. We find that the model can explain major photometric and spectroscopic features of the system, including (i) the relative (visual) luminosities of the degenerate dwarf, of the disk, and of the companion star, (ii) the relative amplitude and pulse profile of the 71$^s$ periodicity, and (iii) the high effective temperature and relatively low luminosity of the degenerate dwarf. We predict that the rotation period of the degenerate dwarf is 142$^s$, and that consequently (i) the polarization of the emitted radiation may rotate through 360° each 142$^s$ and (ii) it is likely that detailed photometric observations can distinguish, at some level, between alternate pulses. Finally, we speculate that the magnetic field in DQ Her is an internal fossil field exposed by an earlier nova outburst. (auth)

**20644** REVISED ELEMENTS OF EIGHT VISUAL BINARIES. Heintz, W. D. (Swarthmore College, PA). Astron. J.; 79: No. 3, 397-400(Mar 1974).

Orbital elements, dynamical parallaxes, and masses have been computed for the double stars listed in Table I of this article. $\sigma$ Ori (ADS 4241) is the most massive visual binary known. (auth)

**20645** RADIAL VELOCITY CURVES OF HD 101799. Sistero, R. F.; Castore de Sistero, M. E. (Universidad Nacional de Cordoba, Argentina). Astron. J.; 79: No. 3, 391-396(Mar 1974).

Radial velocities of the W UMa star HD 101799 were measured on spectrograms at 39 A/mm. Spectroscopic elements are given from a weighted mean of five radial velocity curves derived from measurements of individual absorption lines (λλ 4005, 4045, 4325, $H_\delta$, and $H_\gamma$). The masses of the components and absolute dimensions were found by combining these elements with the photometric orbital parameters. The primary component is of spectral type F8, while the secondary is a F5 star; the system nearly fills the critical equipotential Roche surface, probably in a noncontact configuration. (auth)

**20646** COLOR–MAGNITUDE DIAGRAM OF M14. Kogon, C. S. (Univ. of Western Ontario, Canada); Wehlau, A.; Demers, S. (Univ. of Western Ontario, London). Astron. J.; 79: No. 3, 387-390(Mar 1974).

B and V magnitudes of about 1000 stars in the globular cluster M14 were measured. The data were used to obtain a color–magnitude diagram which extends to slightly fainter than the RR Lyrae stars. Attention is drawn to the lack of horizontal branch stars to the red of the variable star gap such as would be expected for this cluster. On the basis of colors observed for RR Lyrae stars the reddening is estimated at 0.35, considerably lower than that given by other authors. Such a value for the reddening leads to an increased distance modulus of $(m-M)_0 = 15.7 \pm 0.6$. (auth)

**20647** PHOTOGRAPHIC PHOTOMETRY IN THE FIELD OF NGC 2264. Koch, R. H.; Perry, P. M. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 79: No. 3, 379-386(Mar 1974).

A new photographic investigation of NGC 2264 is described. For the historical variables and numerous new variables, the amplitudes of variation or limiting magnitudes are given. A small selection of the variables may possibly be eclipsing pairs, but it is suggested that shell activity may be the dominant cause of the light variations for these objects even if they are binaries. (auth)

**20648** Hγ EQUIVALENT WIDTHS IN THE OPEN CLUSTER NGC 7243. Hill, G.; Fisher, W.; Allison, A. (Dominion Astrophysical Observatory, Victoria, B. C.). Astron. J.; 79: No. 3, 376-378(Mar 1974).

Measurements of the equivalent width of Hγ are presented for 23 stars in the young open cluster NGC 7243. By using the $M_v[W_\gamma, (B-V)_0]$ calibration of Balona and Crampton (1974) a cluster distance modulus of 9.4 ± 0.1 (m.e.) has been determined. The $M_v$ ($\beta$) calibration of Crawford (1972) and the Hγ calibration of Balona and Crampton are compared for NGC 7243 and the Pleiades. (auth)

**20649** PARALLAX AND ORBITAL MOTION OF EPSILON ERIDANI. van de Kamp, P. (Swarthmore College, PA). Astron. J.; 79: No. 4, 491-492(Apr 1974).

Measurement of 900 plates on Epsilon Eridani taken with the Sproul 24-in. refractor on 238 nights over the interval 1938-1972 give a value of 0.302 ± 0.002″ (p.e.) for the relative parallax. The star appears to have perturbation with a period of 25 yr and a semiaxis major of 0.0191 ± 0.0018″; the mass of the unseen companion has a minimum value of $0.006M_\odot$. (auth)

**20650** ANGULAR DIAMETER OF 87 LEONIS. Dunham, D. W.; Evans, D. S.; Sandmann, W. H. (Univ. of Texas, Austin). Astron. J.; 79: No. 4, 483-484(Apr 1974).

The angular diameter of 87 Leo, (HR 4432) a K4III star, was determined on May 12, 1973, at occultation using the McDonald 36-in. telescope. The trace was analyzed and yielded a diameter of 3.7 arcms for a uniform disk and 4.1 arcms for a fully darkened disk with an uncertainty of 10% leading to an effective temperature near 3590 K. (auth)

**20651** ANGULAR DIAMETER AND EFFECTIVE TEMPERATURE FOR V CANCRI FROM AN OCCULTATION OBSERVATION. McGraw, J. T.; Angel, J. R. P. (Univ. of Texas, Austin). Astron. J.; 79: No. 4, 485-488(Apr 1974).

An occultation observation in the near infrared of the S-type Mira variable V Cancri made on April 11, 1973, at McDonald Observatory yields an angular diameter near 2.8 milliseconds of arc for a fully darkened disk at phase 0.74 on the visual light curve. An estimated value of the bolometric correction leads to an effective temperature near 2055 K. The result accords well with other temperature estimates for this and similar stars. The linear radius is found to be 400 ± 115 R. (auth)

**20652** C–M DIAGRAM FOR M80 OBTAINED WITH A NEW PHOTOGRAPHIC CALIBRATION TECHNIQUE. Harris, W. E.; Racine, R. (Univ. of Toronto). Astron. J.; 79: No. 4, 472-479 (Apr 1974).

New photographic photometry in B and V to a limiting magnitude $V \simeq 17.8$ is presented for the southern globular cluster Messier 80 (NGC 6093), the cluster which was the seat of the nova T Sco of 1860. The color–magnitude diagram strongly resembles that of M13 and is characteristic of moderately metal-poor halo clusters. The horizontal branch appears at $V \simeq 15.9$, giving an estimated cluster distance of 9.5 kpc. Most of the horizontal-branch stars are concentrated to the blue side of the RR Lyrae region, but there is an additional small group of HB stars lying in the middle of the variable strip which may be undiscovered low-amplitude variables. Attention is also drawn to a gap in the giant branch, and to three "UV-bright" stars which appear above the horizontal branch and to the blue of the giant branch. The three known short-period variables in the cluster appear to be RR Lyraes from their position in the C–M diagram, and the one known long-period Cepheid is shown to obey the known period–luminosity relation for Population II Cepheids. Finally, the cluster distance modulus is used to redetermine the luminosity of the nova T Sco. Comparison in the [log $t_2$, $M_{PG}$(max)] plane with other galactic novae with independent luminosity determinations shows excellent agreement. (auth)

**20653** LOCAL COMPLEX OF O AND B STARS. I. Distribution of Stars and Interstellar Dust. Stothers, R. (Goddard Space Flight Center, New York); Frogel, J. A. Astron. J.; 79: No. 4, 456-471(Apr 1974).

The O-B5 stars, supergiants, young clusters, and associations within 1 kpc of the Sun populate two flat systems inclined to each other by 19 to 22°. The present paper discusses the historical background, statistical significance, composition, spatial arrangement of the contents, and interstellar extinction in the two belts. A more or less random distribution in space and in age characterizes the O-B5 stars of the "galactic belt," which is aligned nearly along the Milky Way. The "Gould belt" is inclined to the Milky Way (north in Sco-Oph and south in Orion), and exhibits a projected distribution of O-B5 stars in its mean plane that resembles a "dragonfly," with five major features defining it. A crude "diameter" of the system is 750 to 1000 pc, and the Sun's position is eccentric, lying toward Ophiuchus. The nuclear age of the system, while not unique, may be characterized as $3 \times 10^7$ yr from the spectral type of the broad main-sequence turnup near B2.5. Most of the O-B2 stars and youngest stellar groups near the Sun belong to the Gould belt, but both belts have approximately equal space densities of B3-B5 stars and similar average values of interstellar extinction. Although the Gould belt is about three times as compressed vertically as is the galactic belt, each belt shows the same increasing concentration to a plane for the following objects: stars, interstellar dust, and centers of star groups. A small "hole" around the Sun occurs in the distribution of dust and O-B5 stars. (auth)

**20654** REALITY OF STAR TROOPS. Hopmann, J. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl.; 181: No. 4-7, 111-149 (1973). (In German).

The existence of very distant but physically connected double stars and small star troops is considered. In connection with the attempt to establish the existence of such stars within the framework of a critical probability-theoretic approach, a number of recommendations concerning the evaluation of calculated mean errors are reviewed in view of some premature conclusions that have been reached in the recent literature. To test the reality of star troops, a theorem is developed which is then applied to data obtained by Onegina (1958) and Deutsch (1958) for the group 4,5 Vul and in Aquila. In this case most, but not all of the examined star troops could be shown to be real. They occur in large numbers, as is shown by the recent catalog of Hoffleit. The fine structure of the circumsolar space consists, by extension of the ideas of Klinkerfuss and Kapteyn, predominantly of such motion groups. (IAA)

**20655** ELEMENTS OF SOME VARIABLE STARS IN CYGNUS CLOUD. Pinto, G.; Romano, G. (Univ., Padua). Soc. Astron. Ital., Mem.; 44: 649-664(1973).

Improved data and light curves are given for some 14 variable stars in the Cygnus cluster. An electronic computer was used in revised data calculations. Tables of revised elements are given for the stars. (IAA)

**20656** DISTRIBUTION OF MASS RATIOS BETWEEN THE COMPONENTS OF BINARY SYSTEMS. Fracastoro, M. G. (Osservatorio Astronomico, Pino Torinese, Italy). Soc. Astron. Ital., Mem.; 44: 643-647(1973). (In Italian).

Results of a determination of the mass ratios between 367 visual binary systems and 243 spectroscopic binary systems are reviewed. It is found that in 6.2 per cent of the cases the mass ratio for visual binaries is greater than 4, while in the case of spectroscopic binaries the mass ratio is greater than 4 in only 2.3 per cent of the cases. In addition, it is found that mass ratios less than 1.3 prevail among spectroscopic systems, while mass ratios greater than 1.3 prevail among visual systems. (IAA)

**20657** MODELS REGARDING THE KINEMATICS OF STAR CLUSTERS. Dvorak, R.; Goebel, E. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl.; 181: No. 1-3, 77-109(1973). (In German).

The reliability of the results obtained by Ferrari d'Occhieppo and Göbel in a study of the Orion cluster was investigated with the aid of a model of the field of stars. Attention is given to the accuracy of the results obtained in an approach in which several independent catalogs are taken into account in order to improve the data. A three-dimensional model of the positions, motions, and brightness values of 250 field stars and 250 cluster stars is produced. The model serves as a basis for the compilation of an "ideal" catalog which represents "true" values without any observational errors. (IAA)

**20658** CONTINUAL PHOTOELECTRIC MONITORING OF FLARE STARS, VIII YZ CMi, AD LEO, AND UV CET/1972/. Ichimura, K.; Shimizu, Y.; Watanabe, E.; Okada, T. Tokyo Astron. Bull., Ser. II; No. 224, 2607-2612(24 Apr 1973).

**20659** NARROW-BAND PHOTOMETRY OF 32 CYGNI DURING THE 1971 ECLIPSE. Sato, H.; Saito, M. Tokyo Astron. Bull., Ser. II; No. 227, 2627-2632(6 Oct 1973).

**20660** THREE REMARKABLE VISUAL MULTIPLE STARS. Hopmann, J. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl.; 181: No. 1-3, 9-27(1973). (In German).

The stellar systems considered include the triple system ADS 8695-35 Comae, the triple system ADS 9476-Aitken 14, and the quadruple system ADS 7114-iota UMa. The quadruple system is possibly at the present time in a state of disintegration because of pronounced mutual perturbations. Observational data for the stellar systems are presented in a number of tables. (IAA)

**20661** EVOLUTION OF A 15-SOLAR-MASS STAR. Chiosi, C.; Nasi, E. (Univ., Padua). Soc. Astron. Ital., Mem.; 44: 665-670(1973).

The evolution of a star having a mass equal to 15 solar masses is analyzed up to the point of helium depletion in its core. The results are compared with those for star models of different initial chemical compositions. Diagrams are plotted for the helium depletion process. (IAA)

**20662** ULTRAVIOLET OBSERVATIONS. Hack, M. (Osservatorio Astronomico, Trieste, Italy). Soc. Astron. Ital., Mem.; 44: 625-627(1973). (In Italian).

The importance of ultraviolet observations in astrophysics is illustrated by reviewing the results obtained hitherto from observations of mainly high-temperature stars. Observations of mass loss in supergiants are cited, as well as observations of C and N lines in Wolf-Rayet stars, observations of resonance lines in the variable stars beta CMa and beta Cep, and observations of Ap and Bp stars, advanced-type stars, and the close binary beta Lyrae. Also cited are observations of the interstellar gas and interstellar extinction, and photometric observations of clusters and galaxies. (IAA)

**20663** PROBLEMS AND ACHIEVEMENTS OF NUCLEAR ASTROPHYSICS. IV. Rapid Neutron Capture and Tertiary Processes of Nucleosynthesis. Kuchowicz, B. (Univ., Warsaw). Postepy Fiz.; 25: No. 5, 475-495(1974). (In Polish).

A brief outline of the rapid neutron capture process is given; this process is responsible for the synthesis of heavy nuclides (up to the superheavy ones), and is usually located in supernovae. Two tertiary processes of nucleosynthesis: the p-process (regarded as being responsible for the production of rare, neutron-deficient species of heavy nuclides), and the l-process (responsible for the production of the Li-Be-B group) are surveyed. Secondary changes of elemental and isotopic composition in synthesized matter may originate also from alpha-decay and spontaneous fission following the r-process. Finally, some general conclusions from the study of the nucleosynthesis process are presented, with a brief list of related problems of nuclear astrophysics, which could be touched only very briefly in this series of reviews. (auth)

**20664** LOW-DISPERSION OBSERVATIONS OF THE SPECTRA OF 25-OF-TYPE STARS BETWEEN 5850 AND 8750 A. Andrillat, Y. (Laboratoire d'Astronomie, Montpellier, France); Vreux, J. M. Bull. Cl. Sci., Acad. Roy. Belg.; 60: No. 4, 430-435(6 Apr 1974). (In French).

Near infrared spectrograms (5850 to 8750 Å) of 25 Of type stars were obtained between 1971 and 1973 at the Haute Provence Observatory. The main features observed in the spectral range are due to H I and He I. $H_\alpha$ is never observed in emission when He II $\lambda$ 4686 is in absorption, the reverse is not true. (auth)

**20665** STRUCTURE OF THE OH/INFRARED OBJECT NML CYGNUS. I. Analysis of the Near-Infrared Image. Herbig, G. H. (Univ. of California, Santa Cruz); Lorre, J. Astrophys. J.; 189: No. 1, 73-74(1 Apr 1974).

Direct photographs of the image of NML Cyg obtained at an effective wavelength of about 8000 Å at the prime focus of the Lick 120-inch (3-m) reflector were analyzed photometrically in an attempt to determine if the image of the star is extended or nebulous. It was concluded that no nebulosity comparable with that at VY CMa is present, and that the image of NML Cyg is entirely stellar: the star is indistinguishable from the image of a uniform disk 0.7" or less in diameter. Thus, there is no extension of NML Cyg comparable with the size of the 1612-MHz source (about 2.5" and 3.5") determined by Davies, Masheder, and Booth. (auth)

**20666** STRUCTURE OF THE OH/INFRARED OBJECT NML CYGNUS. II. Analysis of the OH Interferometry. Herbig, G. H. (Univ. of California, Santa Cruz). Astrophys. J.; 189: No. 1, 75-79(1 Apr 1974).

The 1612-MHz OH interferometry of NML Cyg published by

Davies, Masheder, and Booth was analyzed in terms of pure radial expansion. It was found that the positions and radial velocities of most of the very complex OH structure, which covers an area of about 2.5″ by 3.5″, can be explained by simultaneous ejection bout 100 ± 20 years ago (if the distance is 500 pc) from a center lying near one edge of the source. The expansion velocity is 46 ± 2 km $s^{-1}$. The three-dimensional map of NML Cyg that can then be constructed shows that all the Oh lies in the hemisphere centered at the Earth as seen from the expansion center. It is suggested that the absence of receding OH in this and similar double-peaked OH sources is due to confinement of the OH maser emission to directions away from the infrared pumping source. The radial velocity of the M-type star measured at 0.8 $\mu$, and the 4.7-$\mu$ CO absorption velocity observed by Geballe, Wollman, and Rank, fit well into this model. The latter spectrum is believed to be produced in material of the expanding shell that is projected upon the infrared source. It may be that the OH maser emission is detectable only at special points in the expanding envelope around the M star. (auth)

**20667** COALSACK. II. Photometry of Suspected Flare Stars. Weaver, W. B. (Case Western Reserve Univ., Cleveland). Astrophys. J.; 189: No. 1, 81-83(1 Apr 1974).

$UBVI_{ph}$ photographic photometry was obtained for most of the rapid variables discovered in the Coalsack by Andrews. No significant number of these stars are nebular flare stars, UV Ceti stars or T Tauri stars, but their colors and objective-prism spectra (when available) are consistent with ordinary reddened early-type stars. (auth)

**20668** AGE OF $\alpha$ CENTAURI. Boesgaard, A.M.; Hagen, W. (Univ. of Hawaii, Honolulu). Astrophys. J.; 189: No. 1, 85-87(1 Apr 1974).

The rotational velocity, Li content, and Ca II emission intensity were used to determine the age of the $\alpha$ Cen triple system by comparison with Skumanich's decay curves. High-dispersion is (1.7–3.4 Å $mm^{-1}$) spectrograms were obtained of $\alpha$ Cen A (G2 V), $\alpha$ Cen B (dK1), and the Sun. The rotational velocity of $\alpha$ Cen A is apparently 10 percent greater than that of the Sun, which gives an age of $3.6 \times 10^9$ years. An upper limit of 6.2 mÅ on the equivalent width of the Li line results in a lower limit for the age of $4 \times 10^9$ years. The Ca emission intensity is comparable to that of the Sun and not more than 50 percent greater than the solar intensity; this value gives a lower limit of $2 \times 10^9$ years. It is concluded that $\alpha$ Cen A is at least 3 billion years old, which is inconsistent with the expected age of $4 \times 10^9$ years for $\alpha$ Cen C, a dM4e flare star. (auth)

**20669** INFRARED FLUXES, SPECTRAL TYPES, AND TEMPERATURES FOR VERY COOL STARS. Dyck, H. M.; Lockwood, G. W.; Capps, R. W. (Kitt Peak National Observatory, Tucson, AZ). Astrophys. J.; 189: No. 1, 89-100(1 Apr 1974).

From narrow- and broad-band photometry between 0.55 and 10.2 $\mu$, complete energy distributions, photometric spectral types, and total fluxes are derived for a sample of cool giants, Mira variables, and IRC stars. From stars lacking infrared excesses, an intrinsic relation for color temperature versus spectral type is found for M0–M10 stars as well as bolometric corrections for the fluxes at 1.04 and 2.2 $\mu$. The effective temperature scale for cool stars is reexamined and its sources of error are discussed. (auth)

**20670** METALLICISM IN BORDER REGIONS OF THE Am DOMAIN. III. Analysis of the Hot Stars Alpha Geminorum A and B and Theta Leonis. Smith, M. A. (Univ. of Texas, Austin). Astrophys. J.; 189: No. 1, 101-111(1 Apr 1974).

The fine curve-of-growth analysis previously applied to a number of Am and Fm stars is extended to some of the hottest known Am stars. The abundances of $\alpha$ Gem A and B and $\theta$ Leo with $\alpha$ Lyr were compared. The results suggest that not only are $\alpha$ Gem A and B metallic lined but so is the heretofore A2 V spectral standard $\theta$ Leo. In addition, with a $T_{eff}$ of 10, 200° K, $\alpha$ Gem becomes the hottest known Am star. The most important result to emerge herein is the discovery of a moderate deficiency of helium in $\alpha$ Gem A (and probably also in $\theta$ Leo and Sirius). This represents the confirmation of an important prediction of the subsurface diffusion model. In all three Am stars iron shows the largest enhancements yet found for the Am class. The [Sc/Fe] and [Ca/Fe] anomalies are nearly normal, and [Sc] and [Ca] themselves actually become enhanced. This fact and the small positive [Zr/Fe] anomalies found herein can be predicted from the diffusion model. Finally, the heavy element anomalies appear somewhat larger than those found among the cooler Am and Fm stars. The hot border of the Am domain nearly coincides with the cool border of the Hg–Mn star region. There is, however, no other evidence to suggest yet that there is a connection between the two groups. (auth)

**20671** PULSATIONAL STABILITY OF STARS IN THERMAL IMBALANCE. II. An Energy Approach. Davey, W. R. (Univ. of Queensland, St. Lucia, Australia); Cox, J. P. Astrophys. J.; 189: No. 1, 113-124(1 Apr 1974).

A general expression is derived for the rate of change of the total pulsation energy (kinetic plus potential) of a star in thermal imbalance. It is shown that no intrinsically second-order terms appear for the case of infinitesimal oscillations. The present analysis does not explicitly invoke the quasi-adiabatic approximation. Quantitative agreement with Simon and with Kato and Unno is obtained in certain special cases. It is shown, however, that this energy approach does not correctly describe the growth or decay of the pulsation amplitude, and hence cannot be the correct approach to the thermal imbalance problem (as must also, presumably, be the case with the energy approaches used by the above authors). Moreover, this approach leads to disagreement with a result due to Unno and also with the results of the "small perturbation" approach used by Cox, Hansen, and Davey. Exact agreement with this latter approach can be obtained in at least a certain class of cases if the stability coefficient is defined in terms of the average rate of change of total pulsation kinetic energy alone. Also, this new definition agrees precisely with the direct solution of the appropriate differential equation in at least two cases. (auth)

**20672** NUMERICAL SIMULATION OF THE GAS FLOW IN CLOSE BINARY SYSTEMS. Prendergast, K. H.; Taam, R. E. (Columbia Univ., New York). Astrophys. J.; 189: No. 1, 125-136 (1 Apr 1974).

A hydrodynamical calculation of the gas flow in a semidetached close binary system is presented. The steady-state solutions for three separate cases are considered, viz., synchronous rotation of both components, nonsynchronous rotation of the secondary (less massive) component, and nonsynchronous rotation of the primary (more massive) component. In all cases a shock (hot spot) forms on the surface of the primary. In addition, a turbulent region probably forms from a shock resulting from the collision of the returning stream (the stream that completes a full orbit around the primary) with the main stream between the components. Nonsynchronous rotation of the secondary leads to a ring around the primary, with the gas flowing along nearly circular streamlines. Also, a density protuberance is seen in the vicinity of the advancing hemisphere of the primary component. In contrast, a detachment of the stream from the surface of the primary in the same vicinity of the advancing hemisphere of the primary results in the other two cases. In addition, the streamlines in this region are more elliptical in shape. Finally, a theoretical velocity curve is constructed, and an attempt is made to compare it with an observational velocity curve. (auth)

**20673** ELECTRON–HYDROGEN PHOTOATTACHMENT AS A SOURCE OF ULTRAVIOLET ABSORPTION. Drake, G. W. F. (Univ. of Windsor, Ont.). Astrophys. J.; 189: No. 1, 161-163(1 Apr 1974).

The absorption coefficient is calculated for the photoattachment process in which a hydrogen atom, an electron, and a photon combine to form the $2p^2\ ^3P$ state of $H^-$. The process is surprisingly efficient and should be considered as a source of continuous ultraviolet absorption in stellar atmospheres or laboratory plasmas with high electron densities. (auth)

**20674** UV-EXCESSES OF CEPHEID VARIABLES. Nikolov, N. S. (Univ., Sofia); Ivanov, G. R. Astron. Nachr.; 295: No. 5, 207-216(1974).

The uv radiation of the Cepheid variables was studied through photoelectric observations in the UBV system using the intrinsic U–B colors as a basis. The uv excesses in maximum light were found to correlate with other characteristics of these stars, such as period and amplitude defects. The correlations are probably connected with the instability strip on the HR diagram as well as with the evolution of the stars, but the physical causes of the differences in uv radiation cannot be determined by photometry alone. (IAA)

**20675** PHOTOELECTRIC STUDY OF THE THREE MANGAN-STARS HD 207857, HD 220933, AND HD 225289. Hildebrandt, G.; Schoeneich, W. (Central Inst. for Astrophysics, Potsdam, Ger.). Astron. Nachr.; 295: No. 5, 217-221(1974). (In German).

**20676** TRAVELING WAVES IN A STAR CONSTRUCTED ON THE BASIS OF A GENERALIZED ROCHE MODEL. III. Eigenfunction Series Expansion. Moussiaux, A.; Ronveaux, A. (Univ., Namur, Belg.). Bull. Soc. Roy. Sci. Liege; 43: No. 3-4, 214-222 (1974). (In French).

**20677** ORBIT EVOLUTION OF THE ECLIPSING BINARY SYSTEM BD + 16°516 AND THE ROTATION PERIOD OF ITS WHITE DWARF. Hills, J. G.; Dale, T. M. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 30: No. 1, 135-139(Jan 1974).

Because this binary system is a member of the Hyades moving group and one of its components has been a white dwarf for much less than the age of the cluster, one can find the main sequence characteristics of the white dwarf progenitor. The fact that the binary is still attached to the loosely bound Hyades group indicates that mass loss from the system was a very gradual process which occurred over many orbital periods of the binary. This simplifies the calculation of the dynamical evolution of the binary system; e.g., one can specify the initial, pre-evolution binary system by one parameter, the initial mass, $M_{02}$, of the white dwarf companion. Once $M_{02}$ is specified the initial semi-major axis, $a_0$, and period, $P_0$, of the system are known. Because the main sequence characteristics of the white dwarf progenitor are known and empirical measurements of the mass and radius of the white dwarf are available, its present rotation period, $P_f$, from the initial rotation period of its progenitor which is taken to be $P_0$. Since the permitted initial models of the system predict greatly different values for $P_f$, a measurement of $P_f$ can greatly restrict the possible range of the initial model. The Doppler effect resulting from the rotation of the white dwarf causes a brightness variation across its surface which can be measured by comparing the eclipse observations of the white dwarf during ingress to those during egress. The available observations indicate that the equatorial velocity of the white dwarf must be less than 750 km/s, and its rotation period must be in excess of one minute. This is found to require that $M_{02} = 0.18\ M_\odot$; $a_0 = 15\ R_\odot$; the mass transferred from the white dwarf progenitor to the companion, $\Delta M_c = 0.62\ M_\odot$; the amount of mass lost from the system, $\Delta M_1 = 0.48\ M_\odot$; and the average velocity of ejection of the gas from the white dwarf progenitor, V = (300–500) km/s. (auth)

**20678** ABSOLUTE FLUX MEASUREMENTS IN THE ROCKET ULTRAVIOLET. Bohlin, R. C.; Frimout, D.; Lillie, C. F. (Univ. of Colorado, Boulder). Astron. Astrophys.; 30: No. 1, 127-134(Jan 1974).

A two-channel spectrometer was calibrated in the wavelength region 1200 to 3400 Å and flown on an Aerobee rocket to observe the stars $\alpha$ Lyr, $\eta$ UMa, and $\zeta$ Oph. Standard tungsten lamps provided the absolute calibration down to 2250 Å and a photodiode calibrated by the National Bureau of Standards was the reference at shorter wavelengths. The molecular branching-ratio technique of relative calibration using the gases CO, NO, and $N_2$ was a check on the absolute calibration. The flux from $\eta$ UMa agrees with the prediction of a hydrogen line blanketed model atmosphere within 10% between 1700 and 3400 Å and within 4% over most of this wavelength region. (auth)

**20679** THEORETICAL LOW-MASS MAIN SEQUENCE. Grossman, A. S. (Iowa State Univ., Ames); Hays, D.; Graboske, H. C. Jr. Astron. Astrophys.; 30: No. 1, 95-103(Jan 1974).

The structure of stars on the theoretical low-mass main sequence for the mass range $0.085-0.5\ M_\odot$, spectral range M0 to M8, was investigated. A chemical composition of X = 0.68, Z = 0.03 and $l/H_p$ ratio of 1 were chosen. (WDM)

**20680** BALMER DISCONTINUITY OF THE Ap STARS. Gerbaldi, M. (Institut d'Astrophysique, Paris); Hauck, B.; Morguleff, N. Astron. Astrophys.; 30: No. 1, 105-109(Jan 1974).

The Ap stars of the Osawa catalog measured in the Geneva and Barbier–Morguleff system show that the Balmer discontinuity is affected by the particular character of the stars. (auth)

**20681** BLACK-HOLE PHYSICS: SOME EFFECTS OF GRAVITY ON THE RADIATION EMISSION. de Felice, F.; Nobili, L.; Calvani, M. (Univ., Padua). Astron. Astrophys.; 30: No. 1, 111-118(Jan 1974).

The effects of the gravitational dragging on the electromagnetic radiation emitted by particles which move on right bound orbits around a Kerr black hole are found to change the photon frequency shift $1 + z$ from values $\lesssim 1$ to values $\gg 1$ with a periodicity of $\sim 10^{-4}(M/M_\odot)$s. The energy of the emitted radiation, as measured by a distant observer, turns out to be confined in pulses with the same periodicity. (auth)

**20682** OBSERVATIONS OF THE [O III], LAMBDA 5007 Å EMISSION LINE FROM THE HELIX NEBULA. Taylor, K. (Univ. of Manchester, Eng.). Astron. Astrophys.; 30: No. 1, 45-49(Jan 1974).

Observations of the [O III] · $\lambda$ 5007 Å emission line were made of the Helix planetary nebula (NGC 7293) using a pressure-scanned double-etalon, PEPSIOS-type monochromator combined with the 106 cm reflector at the Pic du Midi Observatory. 32 positions on the object were observed with a 2 minute arc beam on the sky. Each position displayed multi-peaked profiles with up to 4 components appearing in the deconvolution of the scans. However systematic behavior of the separate features from position to position were not observed and no evidence for a simple expanding shell model could be found. (auth)

**20683** LOW-VELOCITY M DWARFS AND STAR FORMATION. Biermann, P. (Columbia Univ., New York). Astron. Astrophys.; 30: No. 1, 31-36(Jan 1974).

Making the plausible assumption that the recently discovered high number of low velocity M dwarfs is local neither in space nor in time, two interesting consequences can be inferred: (a) The velocity dispersion of Pop I stars is a property largely given to them at formation. (b) The amplitude of the gravitational field of spiral structure changes only on time scales comparable with the lifetime of the Galaxy. The arguments leading to these conclusions give the basis for a discussion of the three known sites of star formation, OB associations, T Tauri associations, and open clusters; it is speculated that clusters are formed from clouds and OB associations from intercloud medium. (auth)

**20684** INFRARED OBSERVATIONS OF HD 65750, A RED GIANT IN A REFLECTION NEBULA. Humphreys, R. M.; Ney, E. P. (Univ. of Minnesota, Minneapolis). Astron. Astrophys.; 30: No. 1, 159-160(Jan 1974).

Photometric observations from .4$\mu$ to 18$\mu$ of the red giant HD 65750 in the reflection nebula IC 2220 reveal the presence of the silicate emission feature at 10 and 20$\mu$. The energy distribution of HD 65750 very closely resembles the Mira variables in the infrared as opposed to pre-main sequence objects. This similarity supports the suggestion that it is an evolved star losing mass perhaps in the process of forming a planetary nebula. (auth)

**20685** ORIGIN OF THE BLUE HALO STARS. Sweigart, A. V.; Mengel, J. G.; Demarque, P. (Yale Univ. Observatory, New Haven). Astron. Astrophys.; 30: No. 1, 13-19(Jan 1974).

The existence in the halo population of uv-bright stars lying above the horizontal branch in luminosity and blueward of the asymptotic branch is interpreted in terms of the final evolution of three stars with masses of 0.453, 0.51, and 0.60 $M_\odot$. These stars, representing different possible evolutionary patterns, are consistent with observations of high-luminosity and subdwarf O stars. In addition the 0.51 $M_\odot$ star provides a satisfactory explanation of the suprahorizontal-branch stars. The stars of 0.51 and 0.60 $M_\odot$ undergo a series of helium-shell flashes, leading to large and rapid excursions in the HR diagram. The present computations cannot account for the subdwarf B stars. Difficulties associated with several interpretations of the subdwarf B stars are discussed. (auth)

**20686** EFFICIENCY OF THE PENROSE PROCESS. Kovetz, A.; Piran T. (Tel-Aviv Univ., Israel). Lett. Nuovo Cim.; 12: No. 2, 39-42(11 Jan 1975).

The Penrose process for extracting energy from a Kerr black hole is discussed. The upper limit to the energy that can be gained in a single Penrose process is calculated. This is determined by calculating the gain in energy and comparing it with the energy of the incoming particle. (JFP)

**20687** SECULAR STABILITY OF A 0.5 $M_\odot$ AND A 1.1 $M_\odot$ STAR DURING HYDROGEN SHELL BURNING PHASES. Gabriel, M.; Noels, A. (Institut d'Astrophysique, Cointe-Ougree, Belgium). Astron. Astrophys.; 30: No. 2, 339-343(Jan 1974).

Evolutionary models of 1.1 $M_\odot$ and .5 $M_\odot$ stars in the hydrogen shell burning phase are tested for secular stability. Contrary to the suggestion of Balton and Eggleton but in agreement with the discussion of Refsdal and Weigert, no instability is found. (auth)

**20688** DETECTION OF NML CYGNUS AT 2.8 CM. Goss, W. M. (Kapteyn Astronomical Inst., Groningen, Netherlands); Winnberg, A.; Habing, H. J. Astron. Astrophys.; 30: No. 2, 349-350(Jan 1974).

A radio source of 12 ± 2 mfu at 2.8 cm apparently associated with the late M-type supergiant NML Cygnus was detected. The detection is discussed and some explanations are briefly sketched. (auth)

**20689** DETERMINATION OF FARADAY ROTATION OCCURRING BETWEEN THE BURST-SOURCE IN THE SOLAR CORONA AND THE EARTH. Bhonsle, R. V.; Mattoo, S. K. (Physical Research Lab., Ahmedabad, India). Astron. Astrophys.; 30: No. 2, 301-303(Jan 1974).

The total Faraday rotation suffered by Type III solar radio bursts, as measured by means of the two bandwidth (7.5 and 12.5 kHz) time-sharing polarimeter at 35 MHz, has been found to be of the order of $10^3$ radians. It is suggested that such low values of the Faraday rotation can be qualitatively explained on the basis of generation of Type III bursts primarily at the second harmonic of the local plasma frequency. (auth)

**20690** INFLUENCE OF BLENDS UPON THE FORMATION OF SPECTRAL LINES. Lites, B. W. (Observatoire de Geneve). Astron. Astrophys.; 30: No. 2, 297-300(Jan 1974).

The effect of blending of normal stellar absorption lines is investigated in order to determine the error introduced when such blending is neglected in line transfer calculations. Solutions of

the radiative transfer equations in some typical blended solar absorption lines demonstrated that, in cases where the line under consideration has only weaker blends confined to wavelengths outside the immediate line core, the neglect of the blending in the radiative transfer computations is indeed a valid approximation. (auth)

**20691** FREE–FREE ABSORPTION OF INFRARED RADIATION IN COLLISIONS OF ELECTRONS WITH NEUTRAL RARE-GAS ATOMS. Stallcop, J. R. (Ames Research Center, Moffet Field, CA). Astron. Astrophys.; 30: No. 2, 293-296(Jan 1974).

A relationship between the inverse Bremsstrahlung absorption cross section and the electron neutral momentum transfer cross section has been utilized to determine the infrared free–free continuum absorption coefficient for the negative ions of helium, neon, argon, krypton, and xenon. The values of the momentum transfer cross section for this calculation have been obtained from experimental measurements. Analytical expressions for the absorption coefficient have also been developed. From the results of this calculation, one can determine the absorption coefficient per unit electron density per neutral atom for temperatures in the range 2500 to 25,000°K. The results are compared with those from tabulations of previous calculations and those computed from theoretical values of the phase shifts for the elastic scattering of electrons by neutral atoms. (auth)

**20692** INFLUENCE OF THE OPACITY VALUES ON STATIC STELLAR MODELS. II. Main Sequence Stars. Parsian, I. (Hamburger Sternwarte, Ger.); Refsdal, S.; Stabell, R. Astron. Astrophys.; 30: No. 2, 275-280(Jan 1974).

The method which was described in the first paper of this series is here applied to zero age main sequence stars of 0.5, 1, 1.8, 5, 9, and 15 $M_\odot$. Particularly the influence of opacity changes on luminosity and effective temperature is discussed. It is found that any small increase in the opacities anywhere in a main sequence star will cause a decrease in luminosity and effective temperature. The largest sensitivity toward opacity changes is usually found when $\varkappa$ is changed in the hotter part of the star, i.e., $\log T > 6.5$. For low mass stars ($M \lesssim 1\ M_\odot$) however, significant effects occur also if $\varkappa$ is changed in the very outer parts, i.e., $\log T \lesssim 3.9$. (auth)

**20693** POSSIBLE THREE-YEAR CYCLE OF $\eta$ CARINAE. Feinstein, A.; Marraco, H. G. (Universidad Nacional de La Plata, Argentina). Astron. Astrophys.; 30: No. 2, 271-273 (Jan 1974).

Recent UBV observations of $\eta$ Carinae combined with slightly older measures show that it has been increasing in brightness since 1940. This new data suggest also a long periodic variation with an amplitude of 0.20m, which is confirmed by the observations published by the southern visual observers. The combined data give a period of $P = 1110 \pm 8$ days. (auth)

**20694** PERIOD VARIATIONS OF THE ECLIPSING BINARY RZ CASSIOPEIAE. Herczeg, T.; Freiboes-Conde, H. (Hamburger Sternwarte, Ger.). Astron. Astrophys.; 30: No. 2, 259-263(Jan 1974).

Three new photoelectric minima of RZ Cassiopeiae are given together with a discussion of the period changes based upon the entire available photoelectric material. The O–C diagram for these well determined epochs of minimum light indicates a rather unusual series of some 10 sudden period changes within 32 years, the $\Delta P$ values lying between –1.8s and +1.8s. Earlier proposals of a possible apsidal motion or light time orbit should therefore be discounted. (auth)

**20695** IRON-RICH STARS HR 511 AND HR 7670. Hearnshaw, J. B. (Observatoire de Meudon, France). Astron. Astrophys.; 30: No. 2, 203-209(Jan 1974).

An iron abundance of [Fe/H] = +0.36 has been obtained from a differential line blanketed model atmosphere analysis of the Fe I spectrum of the low velocity K 0 V star HR 511. Similarly, an abundance of [Fe/H] = +0.26 has been obtained for HR 7670, a high velocity G 6 subgiant. The first star has a large parallax, and it may lie slightly below the main sequence defined by the majority of nearby stars. The second star has an estimated age of about $8 \times 10^9$ yr, a result contrary to the hypothesis that the oldest stars in the Galaxy should be metal poor. (auth)

**20696** MONOCHROMATIC OBSERVATIONS OF THE RING NEBULA IN LYRA (NGC 6720). Louise, R. (Observatoire de Marseille). Astron. Astrophys.; 30: No. 2, 189-197(Jan 1974). (In French).

The ring nebula in Lyra (NGC 6720) was observed through narrow-band interference filters centered respectively on H$\alpha$, H$\beta$, [O III] ($\lambda$ = 5007 Å), [N II] ($\lambda$ = 6584 Å), [O I] ($\lambda$ = 6300 Å), and [S II] ($\lambda$ = 6715 Å + $\lambda$ = 6732 Å). For each monochromatic image, photometric reductions were made for two directions, one along the major-axis of the nebula and one along its minor-axis. Some geometrical parameters were defined from the photometric profile. These parameters were compared to each other for the various observed lines. It was found that the size of the [N II] image was greater (16 to 19%) than the H$\alpha$ one. This confirms the observations of Hua and Louise (1970). On the other hand, the H$\alpha$ and H$\beta$ images were found to have the same sizes. An attempt to study the variation of [O III]/[O I] was made. The shell model proposed by Curtis (1918) and Gurzadyan (1970) was compared with the observations. The principal discrepancy was the high value of the observed brightness ratio between the ring and the center of the nebula. Two other models were suggested: A quasi-flat ring as proposed by Mindowski and Osterbrock (1960) and more recently by Hua and Louise (1970); an oblate spheroid, denser at the equator than at the poles; a program of high spectral resolution observations is needed to differentiate between these two models. These observations would also reveal the presence of a velocity gradient (in the case of a quasi-flat ring) or of line splitting. (auth)

## Quasi-Stellar, Radio, and X-Ray Sources

*Refer also to abstracts 20688 and 20804.*

**20697** (UCRL–51664) NUMERICAL STUDIES OF MASS TRANSFER AND ACCRETION IN X-RAY BINARY SYSTEMS. Alme, M. L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Sep 1974. Contract W-7405-eng-48. 200p. Dep. NTIS $7.60.

Thesis.

Several aspects of mass transfer and accretion in x-ray binary systems were numerically investigated. Computer calculations were performed of (1) the x-ray emission resulting from the accretion of material onto a neutron star; (2) the x-ray heating of the surface of HZ Her; and (3) the x-ray heating of a gas stream leaving HZ Her through the inner Lagrangian point, falling toward Her X-1. In the accretion calculations it was found that for high mass ($> 1.4\ M_\odot$) neutron stars, the emitted spectra differ only slightly from blackbody, particularly at lower luminosities. For intermediate mass neutron stars the spectra differ substantially from blackbody spectra, especially at higher luminosities. The calculated spectra differ greatly from blackbody spectra at all luminosities for low mass neutron stars. The attenuation and diffusion of a beam of x-rays incident on the surface of HZ Her were calculated. Atmospheric hydrogen was assumed to be in LTE. All other elements were treated non-LTE. Compton scattering and energy exchange were included. These time dependent calculations incorporated hydrodynamics with radiation pressure. The calculations indicated that (a) The mass transfer rate dM/dt is too small to sustain a self-excited accretion-powered x-ray mechanism unless the photosphere is close to the Roche limit. (b) dM/dt is insensitive to differences in spectral shape between blackbody and exponential fits to the observed Her X-1 X-ray spectrum. (c) For a fixed energy flux per unit area, dM/dt is a mild function of the angle of incidence for the x rays. (d) Reducing by 10 the relative abundance of elements with $Z > 2$ decreases dM/dt by 7.3, while increasing by 2 the relative abundance of elements with $Z > 2$ increases dM/dt by 1.8. (e) With reduced abundances for $Z > 2$, a large amplitude pulsation of 3 hour period occurs. The response of HZ Her to time variations in the incident x-ray intensity was also studied. Assuming cosmic abundances, the optical modulation resulting from 1.24 s pulsed x rays is about 18 percent. Time of flight smearing over the surface of the star will not reduce this modulation to the observed values. The optical modulation decreases as the relative abundance of materials with $Z > 2$ is decreased. In the calculations of the x-ray heating of the gas stream, it is assumed that cold material leaves HZ Her, flowing through the inner Lagrangian point. The modifications in the hydrodynamical motion due to the X-ray heating is then calculated. One is able to calculate strong x-ray heating effects for some choices of boundary conditions, but is unable to determine if, in general, x-ray heating effects dominate the motion of the infalling gas. (auth)

**20698** OOTY OCCULTATIONS OF 76 RADIO SOURCES. Kapahi, V. K.; Joshi, M. N.; Sarma, N. V. G. (Tata Inst. of Fundamental Research, Bombay). Astron. J.; 79: No. 5, 515-526(May 1974).

Positional and structural information derived from lunar occultations observed at 327 MHz is presented for 76 radio sources, most of them of flux density less than $2 \times 10^{-26}$ $Wm^{-2}$

$Hz^{-1}$. Only 16 sources are optically identified. Two of the stronger sources in the list, viz. PKS 1417−19 and MSH 16−205 have a head−tail type of radio structure. PKS 1417−19 appears to be associated with a small chain of faint galaxies. It is interesting that a close group of five radio sources, each with flux density ≥0.5 f.u. appears to be physically associated with the cluster Zw 0210.1 + 1857. One of the five sources coincides with a 19-mag BSO, while none of the other four is identified with an optical object on the basis of positional agreement. (auth)

**20699** REDSHIFTS OF QUASARS. Abramenko, B. (AEG Rechenzentrum, Frankfurt am Main). Astron. Astrophys.; 31: No. 1, 109-110(Feb 1974).

The notion that the large redshifts of quasars are entirely cosmological is criticized. It is shown that the Hubble diagram of Bahcall and Hills is consistent with a part of the redshift being intrinsic to quasars. (auth)

**20700** OH AND $H_2CO$ ABSORPTION LINE MEASUREMENTS TOWARD SOURCES IN W 31. Wilson, T. L. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 31: No. 1, 83-87(Feb 1974).

The $H_2CO$ absorption was mapped in the direction of the H II regions in W 31, and new OH profiles were taken toward the three continuum peaks. These results confirm the discrepancy between kinematic distances obtained from the H 109α emission and from OH and $H_2CO$ absorption velocities. The velocities of the H II regions deviate from the Schmidt rotation model by as much as 36 km $s^{-1}$, and kinematic distances derived from recombination lines are unreliable for these sources. (auth)

**20701** PULSING X-RAY SOURCES AS JACOBI ELLIPSOIDS. Chanmugam, G. (Louisiana State Univ., Baton Rouge). Astron. Astrophys.; 34: No. 1, 159(Aug 1974).

It is shown that Cen X-3 and Her X-1 are unlikely to be rapidly rotating degenerate stars in the form of Jacobi ellipsoids. (auth)

**20702** MASS OF CYGNUS X-1. Paczynski, B. (Polish Academy of Sciences, Warsaw). Astron. Astrophys.; 34: No. 1, 161-162(Aug 1974).

A lower mass limit for Cyg X-1 is obtained as a function of distance under the assumption that HDE 226868 is not larger than its Roche lobe and noticing that there are no x-ray eclipses, but with no reference to the mass−luminosity relation. At a distance of 2.5 kpc the minimum mass of Cyg X-1 is 9.5 $M_\odot$. If HDE 226868 is not allowed to be underluminous for its mass then the distance to the system cannot be much larger than 2 kpc. (auth)

**20703** RADIO RECOMBINATION LINES IN THE DIRECTION OF SUPERNOVA REMNANTS. Downes, D.; Wilson, T. L. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 34: No. 1, 133-139(Aug 1974).

A search for hydrogen and carbon 134α lines at 2.7 GHz was made in the direction of supernova remnants with the Effelsberg 100-m telescope. An H 134α recombination line was found in the direction of W 49 B at a velocity of 65 ± 10 km $s^{-1}$. Other observations of radio recombination lines toward nonthermal galactic sources are reviewed. The lines observed toward 3 C 391 and W 49 B probably come from H II regions which lie along the line of sight and account for ~30% of the continuum absorption seen toward these sources at 80 MHz. The lines observed toward Sgr A and G-0.6−0.1 come from H II regions in the nuclear disk, which account for all of the absorption at 80 MHz. (auth)

**20704** 21-cm OBSERVATIONS IN THE DIRECTIONS OF 43 HOT STARS AND 34 X-RAY SOURCES. Grayzeck, E. J.; Kerr, F. J. (Univ. of Maryland, College Park). Astron. J.; 79: No. 3, 368-375(Mar 1974).

An atlas of 21-cm emission profiles is presented for the positions of 43 hot luminous stars and 34 x-ray sources. The observations were obtained using the NRAO 140-ft radiotelescope, which has a half-power beamwidth at λ = 21 cm of 21 arcmin, and the 413-channel autocorrelation receiver. A table of hydrogen column densities, $N_H$, under the assumption that the gas can be considered to be optically thin, is also given for the 77 observed directions. (auth)

**20705** A NEW OPTICAL SUPERNOVA REMNANT IN CENTAURUS. Irvine, N.J. (The University of Michigan, Ann Arbor); Irvine, C.E. Astrophys. J. Lett. 192: No. 3, L111-L112 (15 Sept 1974).

Filamentary nebulosity has been found at the position of the radio supernova remnant PKS 1209−51/52. (auth)

**20706** CORRELATED OPTICAL AND INFRARED BEHAVIOR OF OJ 287 AND SIMILAR RADIO SOURCES. Rieke, G.H. (Lunar and Planetary Laboratory, Steward Observatory, University of Arizona); Kinman, T.D. Astrophys. J. Lett. 192: No. 3, L115-L117 (15 Sept 1974).

In the past two years the brightness of OJ 287 has decreased by a factor of 15, but the ratio of the fluxes at wavelengths of 10.5 and 0.44 μ showed no change. Neither was a systematic change with brightness of either the U−B or B−V colors found, although short−term variations in these colors occur. The mean spectral index of OJ 287 is −1.2 in the optical but is significantly flatter in the infrared. Observations of BL Lac, 0735+178, ON 231, B2 0912+29, and B2 1215+30 indicate that the nonthermal components of the spectra of these objects are similar. The lack of X−ray emission from BL Lac by inverse Compton scattering of optical photons indicates a field in the emitting region of over 500 gauss which, for incoherent synchroton radiation, would imply self−absorption at wavelengths longer than 30 μ. This is consistent with what is known of the mean spectrum and with the absence of correlation between the rapid optical and radio variations in objects of this type. (auth).

**20707** INFRARED, RADIO, AND X−RAY OBSERVATIONS OF CYGNUS X−3. Becklin, E.E. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington); Hawkins, F.J.; Mason, K.O.; Matthews, K.; Neugebauer, G.; Packman, D.; Sanford, P.W.; Schupler, B.; Stark, A.; Wynn−Williams, C.G. Astrophys. J. Lett. 192: No. 3, L119-L124 (15 Sept 1974).

Infrared, X−ray and radio observations of Cyg X−3 made during 1973 June through 1973 October are presented. The data show a variety of behaviors. No attempt at interpretation is made. (auth)

**20708** ON CHANGES IN THE PULSATION PERIOD OF HERCULES X−1. Brecher, K.; Wasserman, I. (Department of Physics and Center for Space Research, Massachusetts Institute of Technology). Astrophys. J. Lett. 192: No. 3, L125-L128 (15 Sept 1974).

True changes in pulse period and Doppler variations caused by precession of the periastron line and of the orbital plane are examined and are found to be inadequate to explain the observed variation in the pulsation period of Her X−1. To account for these changes, we suggest that Her X−1 is a triple star system. Implications of this hypothesis are discussed. (auth)

**20709** DETECTION OF THE 10.464−GHz TRANSITION OF−INTERSTELLAR−THIOFORMALDEHYDE. Doherty, L.H.; MacLeod, J.M.; Oka, T. (National Research Council of Canada). Astrophys. J. Lett. 192: No. 3, L157-L160 (15 Sept 1974).

The $4_{13}$−$4_{14}$ transition of thioformaldehyde ($H_2CS$) at 10.46 GHz has been detected in absorption against the galactic center source Sgr B2. The observed line width of 19.5±3 km $s^{-1}$ and velocity of +63 ±3 km $s^{-1}$ are typical of the molecular cloud at the core of Sgr B2. A comparison with the previously observed $2_{11}$−$2_{12}$ transition at 3.14 GHz indicates that the population levels in thioformaldehyde are not thermally distributed. (auth)

**20710** THE IDENTIFICATION AND UBV PHOTOMETRY OF THE VISIBLE COMPONENT OF THE CENTAURUS X−3 BINARY SYSTEM. Krzemiński, W. (European Southern Observatory, La Silla, Chile). Astrophys. J. Lett. 192: No. 3, L135-L138 (15 Sept 1974).

The optical component of the pulsating binary X−ray source Cen X−3 is identified with a faint, $\langle V \rangle = 13.35$, heavily reddened variable star lying slightly outside the error box of the 3U catalog. It shows a double−peaked light curve with an amplitude of about 0.12 mag which agrees in both period and phase with the X−ray data. The shallower minimum coincides in time with the X−ray pulsar eclipse. The estimated distance to Cen X−3 is about 8 kpc. (auth)

**20711** MASS LIMITS FOR THE CENTAURUS X−3 SYSTEM. Avni, Y.; Bahcall, J.N. (Institute for Advanced Study). Astrophys. J. Lett. 192: No. 3, L139-L140 (15 Sept 1974).

Constraints on the mass of Cen X−3 based on the observed amplitude of the optical light curve are discussed. A 2 σ lower limit of 0.6 $M_\odot$ is derived assuming corotation and the interpretation of the ellipsoidal light variations as caused by gravity− and limb−darkening effects. Including the constraints imposed by the eclipse duration, one obtains $m_x = 0.6-1.1$ $M_\odot$ and $m_{optical} = 16.5-18.5$ $M_\odot$. The expected projected half−amplitude of the optical radial velocity is then $V_{opt} \sin i = 15-25$ km $s^{-1}$. The sensitivity of the derived masses to the assumed geometry is demonstrated. (auth)

**20712** IDENTIFICATION OF SOUTHERN HEMISPHERE RADIO SOURCES. III. Optical Objects in the Radio Fields. Lue, P. K. (Western Connecticut State College Observatory, Danbury). Astron. J.; 79: No. 4, 453-455(Apr 1974).

Further identifications and measurements of optical objects in the fields of southern radio sources are presented. Identifications are suggested for nine quasistellar objects (QSO's) or possible QSO's, twenty-three galaxies and four n-type galaxies. The remaining five fields contain faint objects that cannot be reliably classified and, therefore, no identifications were suggested. Although all faint objects near the radio sources were measured and marked on the finding charts, only the position for the best possible candidate is listed. (auth)

**20713** INTENSITY DEPENDENT RADIO SPECTRAL DISTRIBUTIONS IN THE PARKES 2700-MHz SURVEY. Condon, J. J. (National Radio Astronomy Observatory, Charlottesville, VA); Jauncey, D. L. Astron. J.; 79: No. 4, 437-452(Apr 1974).

On the basis of 318-MHz flux densities measured at Arecibo, two-point spectral indices $\alpha(318,2700)$ were determined for all 382 sources north of $\delta = -2°$ in the Parkes 2700-MHz survey. Supplementary 606-MHz observations were made to reduce confusion errors and provide better definition to weak-source curved spectra. Both the steep and flat spectrum portions of the spectral index distribution of 258 sources forming a sample statistically complete down to 0.35 flux units at 2700 MHz were found to be flux density dependent. Spectral differences between optically identified QSO's and galaxies are sufficiently large that the published identifications can be reproduced with 80% reliability on the basis of radio data alone. However, extrapolation of these results to unidentified sources may be meaningless. The radio and optical results are combined to yield a suggested continuum of powerful extragalactic radio source types. (auth)

**20714** COORDINATED OBSERVATIONS OF OJ 287 AT RADIO AND OPTICAL WAVELENGTHS. Kinman, T. D. (Kitt Peak National Observatory, Tucson, AZ); Wardle, J. F. C.; Conklin, E. K.; Andrew, B. H.; Harvey, G. A.; Macleod, J. M.; Medd, W. J. Astron. J.; 79: No. 3, 349-357(Mar 1974).

Observations of the total flux of OJ 287 were made at 11.1, 4.5, 3.7, 2.8, 0.95, and 0.35 cm and at 0.44 $\mu$ during early 1972 when the object had its greatest recorded optical brightness. The linear polarization was measured at 3.7 and 11.1 cm and at 0.4 $\mu$. Significant changes in the total flux in times of the order of a day were found at 4.5 cm and shorter wavelengths. These rapid fluctuations at short centimeter wavelengths were in phase to within a small fraction of a day. No correlation was seen between the optical and radio fluctuations. Linear polarization was found at both radio and optical wavelengths which varied with the same time scales as the total flux. At all observed wavelengths, the position angle tended to show sudden excursions from an otherwise smooth trend. Correlograms of the optical total flux and Stokes parameters give evidence for an eight day periodicity. The consequences of these observations (which do not fit in with the usual expanding cloud model) are briefly discussed. (auth)

**20715** SURVEY OF THE PRESENT STATE OF X-RAY ASTRONOMY. Perola, G. C. (Univ., Milan). Soc. Astron. Ital., Mem.; 44: 539-552(1973). (In Italian).

The present state of knowledge of the distribution and classification of galactic and extragalactic x-ray sources is reviewed. A detailed account is given of the structure and radio and optical properties of galactic sources such as supernova remnants, sources of Sco X-1 type, and sources in binary systems; and of the size and luminosity of extragalactic sources which include Seyfert galaxies, quasars, radio sources, and clusters. (IAA)

**20716** OPTICAL IDENTIFICATIONS OF EXTRAGALACTIC X-RAY SOURCES. Fanti, R. (CNR, Bologna). Soc. Astron. Ital., Mem.; 44: 599-601(1973). (In Italian).

The possibility of detecting optical counterparts of extragalactic x-ray sources is considered. An attempt is made to estimate the accuracy of identifications of optical counterparts of extragalactic x-ray sources observed by the Uhuru satellite. Although a large percentage of these identifications are shown to be spurious, it is noted that the number of spurious coincidences can be reduced to practically zero by considering only sources with error areas less than a certain critical value. (IAA)

**20717** NATURE OF GALACTIC X-RAY SOURCES. Cavallo, G. (CNR, Bologna). Soc. Astron. Ital., Mem.; 44: 553-569 (1973). (In Italian).

A review is given on various classes of galactic x-ray sources which will theoretically be observable by the EXOSAT satellite. Following a detailed listing of the x-ray sources that can be occulted by the Moon in northern and southern orbits of the satellite and of sources that can be occulted by the Earth, a procedure is outlined for gaining effective knowledge of the physics of galactic x-ray sources, dwelling in particular on uncertainties in observations of the periodicities of binary x-ray sources such as Her X 1 and the possible origin of x-ray emission from pulsars. The relation between the soft x-ray diffuse background and certain types of unidentified sources is discussed, as well as the possibility of determining distances to sources by calculating the travel time delay of radiation scattered by interstellar dust. Finally, a description is given of the four phases of evolution of a typical supernova relict, and the possibility of classifying such relicts according to their luminosity is considered. (IAA)

**20718** PHYSICS OF EXTRAGALACTIC X-RAY SOURCES. Cavaliere, A. (Univ., L'Aquila, Italy). Soc. Astron. Ital., Mem.; 44: 571-597(1973). (In Italian).

A detailed account is given of the physical properties of compact x-ray sources associated with active galactic nuclei and of a class of sources called galactic clusters. In discussing compact x-ray sources, the problem of the nature of the energy source for the activity of galactic nuclei and quasars is considered, taking as an example the complex of phenomena correlated with NGC 5128, and noting the ability of the EXOSAT satellite to locate the x-ray source and to unambiguously establish a phenomenological connection between the various emissions of suspected nuclear origin. Turning to galactic clusters, the possibility of using the EXOSAT satellite to establish correlations between their intrinsic luminosity and abundance is noted. An attempt is made to estimate the relative roles of emission due to inverse Compton scattering and bremsstrahlung emission in developing interpretations which genetically link x-ray and radio emission of galactic clusters. Finally, some comments are made on the ability of EXOSAT to shed light on a group of unidentified x-ray objects. (IAA)

**20719** OBSERVATIONS IN THE FIELD OF GAMMA-RAY ASTRONOMY. Sironi, G. (Univ., Milan). Soc. Astron. Ital., Mem.; 44: 617-623(1973). (In Italian).

The factors responsible for the slow pace of research in the field of gamma-ray astronomy are reviewed. Following an outline of what is known with certainty concerning extraterrestrial gamma-ray emission, with special reference to the Crab Nebula, and a listing of possible localized sources of gamma radiation, it is shown why the use of artificial satellites has not appreciably increased the possibilities of identifying celestial sources of gamma rays, and the advisability of carrying out gamma-ray astronomy observations simultaneously with the X-band measurements of the EXOSAT satellite is indicated. (IAA)

**20720** INFORMATION ABOUT QUASARS. Mitton, S. (Cambridge Univ., Eng.). Orion; 32: 156-158(Aug 1974). (In German).

Quasars were first detected in 1963 when the radio source 3C 273 was identified as a star-like object of unusual appearance with an extraordinary degree of redshift. Problems concerning the interpretation of the observed redshifts in the case of quasars are discussed, giving attention to recent observations of quasars with redshifts in the range from 440 to 454%. (IAA)

**20721** NEUTRON STARS AND BLACK HOLES IN X-RAY ASTRONOMY. Weiss, W. (Univ., Vienna). Orion; 32: 150-156(Aug 1974). (In German).

It is pointed out that a black hole, which does not emit any type of radiation, could be detected with the aid of the relations of celestial mechanics if it forms a component of a binary. Such binaries can be detected on the basis of their uncommonly intensive x-ray emission. The characteristics of a few x-ray sources of the about 80 sources observed in the Galaxy are discussed. The majority of the sources are observed as x-ray stars. The significance of x-ray astronomy for the study of the final stages of a star is considered, taking into account the formation of neutron stars and black holes. (IAA)

**20722** RADIO OBSERVATIONS OF X-RAY SOURCES. Grueff, G. (CNR, Bologna). Soc. Astron. Ital., Mem.; 44: 611-613 (1973). (In Italian).

The capabilities of the Croce del Nord radio telescope of the University of Bologna in carrying out observations of x-ray sources are reviewed. It is shown that this instrument will be useful in quickly ascertaining whether a certain x-ray source, whose position is known fairly accurately, is or is not a radio source, and, if it is, will then be able to carry out studies of the variations in time of the radio flux. The instrument will also be able to make periodic measurements of the radio emission of x-ray sources of known position. It is suggested that the greatest contribution of this instrument will be in the field of extragalactic astronomy. (IAA)

**20723** ARE QUASARS DUSTY. McKee, C. F. (Harvard College Observatory, Cambridge, MA); Petrosian, V. Astrophys. J.; 189: No. 1, 17-21(1 Apr 1974).

Two separate techniques have been applied to estimate the amount of dust in the line of sight toward a number of quasars. No evidence for dust was found. Estimates of the dust-to-gas ratio in the emission-line region of quasars suggest that it is much less than the value in our Galaxy. These results provide strong evidence against dust theories of the infrared emission from quasars. The possible relationship between quasars and galaxies is discussed. Finally, a new upper limit on the dust content of the intergalactic medium is obtained. (auth)

**20724** $H_2O$ SOURCE IN SAGITTARIUS B2. Waak, J. A.; Mayer, C. H. (Naval Research Lab., Washington, DC). Astrophys. J.; 189: No. 1, 67-68(1 Apr 1974).

Observations of water molecule radiation from Sgr B2 show a broad, complex spectrum, and a source region which is extended in declination. (auth)

**20725** RADIATIVE ACCELERATION OF GAS CLOUDS NEAR QUASI-STELLAR OBJECTS AND SEYFERT GALAXY NUCLEI. Mathews, W. G. (Univ. of California, Santa Cruz). Astrophys. J.; 189: No. 1, 23-31(1 Apr 1974).

Hydrogen photoionization dominates the momentum transfer by ultraviolet radiation to gas clouds in the emission-line region of quasi-stellar objects and Seyfert nuclei. For radiative acceleration to the observed velocities, the gas clouds must be in pressure equilibrium with the ambient medium and have masses $\lesssim 10^{-5} M_\odot$. Constraints on the nature of the intercloud medium and the effects of differential radiative forces are discussed. The radiative acceleration of fully ionized clouds is proportional to the gas density, which may explain why permitted spectral lines are often broader than forbidden lines. (auth)

**20726** RECOMBINATION-LINE OBSERVATIONS TOWARD SUPERNOVA 3C 391. Chaisson, E. J. (Harvard College, Cambridge, MA). Astrophys. J.; 189: No. 1, 69-72(1 Apr 1974).

Radio recombination-line observations toward the supernova 3C 391 are interpreted in terms of emission from a line-of-sight H II region. Measurements of continuum radiation at high microwave frequencies lend some support to this alternative model. Subsequently, a strict upper limit is found for the ionization rate $\zeta < 14 \times 10^{-15}$ s$^{-1}$ for the cool component of the interstellar gas toward 3C 391. (auth)

**20727** PULSAR FLUX-DENSITY SPECTRA. Backer, D. C.; Fisher, J. R. (National Radio Astronomy Observatory, Green Bank, WV). Astrophys. J.; 189: No. 1, 137-145(1 Apr 1974).

Time-averaged flux-density spectra of 10 pulsars were obtained with simultaneous observations at six frequencies between 250 and 8085 MHz. The effects of interstellar scintillation on the accuracy of the measurements are discussed. All of the pulsars exhibited a power-law spectrum at high frequencies with spectral indices between −1.6 and −3.0. Several of the pulsars show a more positive spectral index at the low-frequency end of the data. (auth)

**20728** ACCRETION FLOWS IN GALACTIC X-RAY SOURCES. I. Optically Thin Spherically Symmetric Model. Buff, J.; McCray, R. (Univ. of Colorado, Boulder). Astrophys. J.; 189: No. 1, 147-155(1 Apr 1974).

Spherically symmetric accretion flows in the presence of a strong x-ray source are discussed. Gas temperature is determined locally by a balance between x-ray heating and radiative cooling. The rate of mass accretion is regulated by the location of the sonic surface, which depends on x-ray luminosity and spectrum. No steady flow is possible unless the source has a soft x-ray cutoff with energy $\gtrsim 2$ KeV. Radiation pressure on the gas due to photoionization may exceed that due to Compton scattering by a large factor. (auth)

**20729** OPTICAL AND RADIO PROPERTIES OF A NEW BL LACERTAE CLASS OBJECT. Crovisier, J. (Observatoire de Meudon, France); Le Squeren, A. M.; Pollock, J. T.; Usher, P. D. Astron. Astrophys.; 30: No. 1, 175-176(Jan 1974).

It is shown that the source B 2 0912 + 29, which has a featureless optical spectrum, a flat radio spectrum, and exhibits optical variations, is a member of the BL Lacertae class of QSO. (auth)

**20730** SEARCH FOR HARD X-RAYS FROM THE TRANSIENT SOURCE 2 U 1543-47. Pizzichini, G.; Spizzichino, A; Vespignani, G. R. (CNR, Bologna). Astron. Astrophys.; 30: No. 1, 161-165 (Jan 1974).

The location of the transient source 2 U 1543-47 discovered by Uhuru in August 17, 1971 was scanned by a hard x-ray detector aboard OSO-6 in May and September 1971. The time of appearance of the source in the 27 to 189 keV range is limited to later than May 22-28, in agreement with a similar result at lower energies. For September 7-11 the observation gives a $3\sigma$ upper limit of $\sim 2 \times 10^{-3}$ and $4 \times 10^{-4}$ photon (cm$^2$ s keV)$^{-1}$ at 35 keV and 60 keV respectively, to a possible hard spectral tail above 20 keV. (auth)

**20731** REDSHIFT MAGNITUDE BANDS FOR QUASISTELLAR SOURCES. Veron, P.; Veron, M. P. (Tel Aviv Univ., Israel). Astron. Astronphys.; 30: No. 1, 155-157(Jan 1974).

Tifft (1973b) has shown that in a redshift–magnitude diagram, quasi stellar sources form a system of parallel bands. If from the sample used by Tifft (1973b), the objects which have no photoelectric magnitude and those which are strongly variable are removed, and if the magnitudes for galactic absorption are corrected, it is found that the statistical weight of this band system is very low. (auth)

**20732** SUSTAINED PULSE FROM ON 231. Pollock, J. T. (Pennsylvania State Univ., University Park); Hall, D. L.; Ambruster, C.; Usher, P. D. Astron. Astrophys.; 30: No. 1, 41-43 (Jan 1974).

Blue photographic plates from 1931 to 1952 reveal the existence of a 1 magnitude pulse of half-width of about 3 years emitted by the quasi-stellar object ON 231 (W Com). Rapid variability of amplitude about 1 magnitude is superposed upon the slower variations. The optical variability and radio spectrum of ON 231 are discussed, and the possibility of the existence of a second optical pulse is explored. (auth)

**20733** ENERGY SPECTRUM OF SCO X-1. Matsuoka, M. (Tokyo Univ.). pp 1177-1182 of International Symposium on Space Technology and Science. Tokyo; AGNE Publishing, Inc. (1973).

From 10th international symposium on space technology and science; Tokyo, Japan (3 Sep 1973).

Sco X-1 is one of few x-ray sources of which the optical counterpart is known. The spectral shape over the infrared optical band and the x-ray band indicated that the emission is due to thermal radiation of a hot plasma cloud. Results of simultaneous optical and x-ray observations are summarized and are discussed. A hot plasma model is developed on the basis of observational results of energy spectrum of Sco X-1. (IAA)

**20734** VARIABILITY OF Cyg X-1. Ogawara, Y.; Takagishi, K. (Tokyo Univ.). pp 1171-1176 of International Symposium on Space Technology and Science. Tokyo; AGNE Publishing, Inc. (1973).

From 10th international symposium on space technology and science; Tokyo, Japan (3 Sep 1973).

Since rapid variation of Cyg X-1 was first discovered by Uhuru, conflicting reports have been presented as to its periodicity. The variation appeared to be periodic in some observations and aperiodic in others. In order to resolve this puzzling situation, further observational data from Uhuru were analyzed. The existence of temporal oscillations with several determined frequencies is suggested from the analysis. (auth)

**20735** INFRARED OBSERVATION OF DR 21 AT 2.2$\mu$. Sibille, F.; Bergeat, J.; Lunel, M. (Observatoire de Lyon, Saint-Genis-Laval, France). Astron. Astrophys.; 30: No. 2, 181-183(Jan 1974).

The radio source DR 21 has been measured at 2.2$\mu$. The flux density in a 40″ beam is .1 fu. The proposed mechanism is pure "free-free + free-bound" emission of the ionized gas. Derived absorption at 2.2$\mu$ is 4 magnitudes. A close spectral similarity between DR 21 and IRS 3/W 3 B is suggested. (auth)

**20736** RADIO STRUCTURE OF QUASARS. II. Wardle, J. F. C.; Miley, G. K. (National Radio Astronomy Observatory, Green Bank, WV). Astron. Astrophys.; 30: No. 2, 305-315(Jan 1974).

The structures of thirty nine quasars with known redshifts were studied with the NRAO interferometer at wavelengths of 11.1 and 3.7 cm. At the shorter wavelength, the angular resolution was about one arcsec. Twelve sources were unresolved, five sources were slightly resolved, and structures were derived at both frequencies for the remainder. Nearly half of the well resolved sources were found to have more than two components. The "largest angular size–redshift" diagram was extended to 166 quasars, and was interpreted in terms of the "ram pressure" model for the containment of extended radio sources. It is shown that for the largest quasars at large redshifts there is a serious conflict between their radiative and dynamic lifetimes. (auth)

**20737** SPECTRAL AND POLARIZATION PROPERTIES OF RADIATION GENERATED BY PLASMA TURBULENCE. Chiuderi, C. (Osservatorio Astrofisico de Arcetri, Florence); Veltri, P. Astron. Astrophys.; 30: No. 2, 265-270(Jan 1974).

A system was studied which consists of a cold plasma containing an ultrarelativistic distribution of electrons. The response of such a system to a periodic electromagnetic disturbance is first discussed. The problem is then specialized to the case of a longitudinal stationary plasma wave. The emission and propagation of radiation in such a system is analyzed in detail by a method which is analogous to the one used in synchrotron radiation theory. Explicit results are given for a power-law distribution of relativistic electrons, and they are compared to synchrotron emission under the same conditions. It is shown that the frequency dependence and polarization are quite similar in the two cases. (auth)

## Solar Phenomena

*Refer also to abstracts 19258 and 19711.*

**20738** (SGD-355-PT-1) SOLAR-GEOPHYSICAL DATA NUMBER 355, MARCH 1974. Part I (Prompt Reports). Data for

February 1974, January 1974. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Mar 1974. 117p. (COM-74-50190-355-1). National Climatic Center, Asheville, NC 28801, $1.25.

Prompt reports are given on data for February 1974 and January 1974. These deal with alert periods, daily solar indices, solar flares, solar radio waves and spacecraft observations. (auth)

**20739** (SGD-355-PT-2) SOLAR-GEOPHYSICAL DATA NUMBER 355, MARCH 1974. Part II (Comprehensive Reports). Data for September 1973, August 1973, and Miscellanea. (National Geophysical and Solar-Terrestrial Data Center, Boulder, Colo. (USA)). Mar 1974. 68p. (COM-74-50190-355-2). National Climatic Center, Asheville, NC 28801, $1.25.

Comprehensive data are provided for September 1973 and August 1973 on solar flares, solar radio emission, selected solar noise burst, and regional flare index. It also has cosmic ray indices for December 1973. (auth)

**20740** HYDRODYNAMIC PLASMA FLOWS IN A STRONG MAGNETIC FIELD. Somov, B. V.; Syrovatskii, S. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 74: 14-72(1974). (In Russian).

On a basis of an approximation of a strong magnetic field, consideration is given to a series of problems in plasma dynamics which relate mainly to the physics of cosmic space. These problems can be separated into two classes: continuous flows in a case of the absence of magnetic field zero points, and flows leading to the occurrence of current layers in the presence of particular zero points. From problems of the first class, consideration is given to flow in the field of a magnetic dipole which increases with time, and applications of the results to the physics of the sun are discussed: the formation of eruptions, condensations, spikes and etc. In problems of the second class the occurrence of a current layer in the field of a plane magnetic dipole is considered. Discussions are given on application of the results to the problem of the occurrence of a geo-magnetic tail and of coronal rays on the sun. By means of numerical integration it was possible to find particle trajectories, and also distributions of velocity and density in the vicinity of the developing current layer. An important result of these calculations is proof of a decrease in plasma density with time near the current layer. (115 references) (SJR)

**20741** NON-LTE ANALYSIS OF THE INFRARED O I-TRIPLETS IN THE SOLAR SPECTRUM. Sedlmayr, E. (Univ., Heidelberg). Astron. Astrophys.; 31: No. 1, 23-35(Feb 1974).

All former LTE analyses of the individual lines of the solar infrared λ 7773 triplet always led to discrepancies between the theoretical results and the observations, especially in the center to limb variation. In this paper the formation of these lines is studied in a multilevel NLTE approach. With an oxygen abundance of $\log \epsilon_0 \simeq 8.60 \ldots 8.70$, a microturbulent velocity of $\xi = 1.5$ km/s and a macroturbulent velocity of $v_t \simeq 3 \ldots 4$ km/s, the center to limb variation of both the theoretical line profiles and the equivalent widths are in close agreement with the observations of Müller et al. (1968). Similarly Altrock's semiempirical results (Altrock, 1968) concerning the NLTE source functions of the λ 7773 and λ 8446 triplets are confirmed. (auth)

**20742** CORONAL RADIANCE IN THE INTERMEDIATE INFRARED. Mankin, W. G.; MacQueen, R. M.; Lee, R. H. (High Altitude Observatory, Boulder, CO). Astron. Astrophys.; 31: No. 1, 17-21(Feb 1974).

An observed value of the spectral mean of the coronal radiance in the intermediate infrared (7.5 to 13 μ) of $9 \pm 5 \times 10^{-7}$ watt-cm$^{-2}$ sterad$^{-1}$ μ$^{-1}$ at 4 $R_\odot$ is presented, with the observed change in radiance with elongation angle over the range 3.5 to 12.5 $R_\odot$. The observations are consistent with the model of silicate emission proposed by Kaiser (1970), but a two component model is required to reconcile these observations and the measurements by Peterson (1971) at wavelengths of 2.2 μ and less. (auth)

**20743** MEASUREMENT OF ELECTRON DENSITIES FROM BERYLLIUM-LIKE ION LINE RATIOS. Jordon, C. (Harvard College Observatory, Cambridge, MA). Astron. Astrophys.; 34: No. 1, 69-73(Aug 1974).

The theoretical dependence of line intensity ratios in the beryllium-like ions C III and O V is discussed. Comparison of the line ratios, calculated using currently available excitation cross-sections and transition probabilities, with those observed shows that the theoretical atomic data cannot account for the observed ratios with electron densities consistent with those given by models derived from absolute line fluxes. However, changes to the excitation cross-sections for permitted and spin-forbidden transitions within the quoted error bars, plus increased mixing of the $2s2p^3P$ levels could account for the majority of the observed ratios. It is therefore premature to conclude that the discrepancy between the observed and calculated lines ratios originates from the existence of solar electron densities, where the C III and O V lines are formed, which are greatly different from those derived from current models of the chromosphere–corona transition region. (auth)

**20744** SOLAR BORON ABUNDANCE. Woehl, H. (Goettingen Univ., Ger.). Astron. Astrophys.; 34: No. 1, 41-42(Aug 1974).

Low-noise infrared photospheric spectra around the wavelength of a proposed boron I-line at 16244.66 Å were obtained with the new infrared spectral scanning system of the Institute for Solar Research of the DFG at Locarno/Switzerland; No absorption line was detectable. Comparisons of this result with predicted boron line intensities give a new upper limit of the solar boron abundance: $\log N_B \leq 2.3$. (auth)

**20745** STATIONARY AND SUPERSONIC PROTON FLUX, PARALLEL TO THE MAGNETIC FIELD. Fridman, M. (Univ., Liege). Can. J. Phys.; 52: No. 23, 2402-2421(1 Dec 1974). (In French).

Using the gyration radius as the parameter to expand the differential equation for the moments, the transport equations for highly supersonic flux, which is parallel to the magnetic field, are obtained. The maximum order one can hope to obtain for the invariants is discussed together with the relation between the function of distribution $f^1$ proposed by Whang and that which must result at 1 AU if $f^1$ or a bimaxwellian function is used at the origin. Using $f^1_0$ at the base (~55 $R_\odot$) it can be estimated that the total loss of heat flux under 1 AU is of the order of 70% on condition that the values obtained after $f^1$ are utilized. (auth)

**20746** PREDICTION OF EARTH-AFFECTING SOLAR ACTIVITY CYCLES. Kuksenko, V. I.; Mikhailovs'kii, V. M. (Physical-Mechanical Inst., Kharkov). Dopov. Akad. Nauk Ukr. RSR, Ser. B; 36: 523-527(Jun 1974). (In Ukrainian).

Theoretical considerations are given for the prediction of solar activity events which contribute to the production of disturbances in the magnetosphere and ionosphere of the Earth. The effects of solar flare cycles on phenomena on the Earth are also discussed. Synchronicity of 20-day chromospheric flare cycles and planetary tidal force cycles is indicated. (IAA)

**20747** HIGHLY CHARGED IONS IN ASTROPHYSICS. Gabriel, A. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Scr.; 9: No. 5, 306-312(May 1974).

From 5th annual conference of the European Group for Atomic Spectroscopy; Lund, Sweden (10 Jul 1973).

The study of highly ionized atoms in astrophysical sources is reviewed with particular reference to the spectroscopy of the sun. The range of spectroscopic observations is surveyed in terms of the general properties of the solar atmosphere. Such spectra contain important information on the physical properties of the emitting regions. Some of the methods are described by which spectral intensities can be related, through the processes of ionization, recombination, and excitation, to the temperature and density structure of the source. (auth)

**20748** SOLAR NEUTRINOS AND THE BEHAVIOR OF THE FERMI COUPLING CONSTANT. Finzi, A. (Israel Inst. of Tech., Haifa). Astrophys. J.; 189: No. 1, 157-160(1 Apr 1974).

The solar neutrino puzzle can be solved if the Fermi coupling constant g is assumed to vary with the gravitational potential. The number of expected absorption events is lower than Davis's upper limit of 1 SNU if at the center of the Sun g exceeds its standard value by a factor of at least 1.3. (auth)

**20749** STUDY OF THE COMPOSITION OF GASES FROM INCLUSIONS IN TEKTITES AND COSMIC DUST. Dolgov, Yu. A. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Meteoritika; No. 33, 122-129(1974). (In Russian).

Results are given of a volumetric microanalysis of gases from inclusions in tektites and silicate microspherules from the region of the Tunguska meteorite fall. It is found that tektites and Tunguska microspherules are similar with respect to chemical composition but differ somewhat with respect to alkali and aluminum oxide content. In particular, silicate microspherules have an $SiO_2$ composition similar to tektites, but differ from tektites in having higher values of $Na_2O$ and lower values of $Al_2O_3$. (IAA)

**20750** RARE-EARTH ELEMENT CONTENT IN FIVE ORDINARY CHONDRITES. Kolesov, G. M. (Inst. of Geochemical and Analytical Chemistry, Moscow). Meteoritika; No. 33, 42-46(1974). (In Russian).

The rare-earth element content was determined in the Saratov, Elenovka, and Pervomaiskii Poselok chondrites (L-group) and in the Zaisan and Zhovtnevyi Khutor chondrites (H-group). It is established that in L-group meteorites there is a slight predominance of light rare-earth elements (REE) in comparison with H-group chondrites; the atomic abundance of light REE in the investigated L-group chondrites is also somewhat higher than in H-group chondrites, but is lower than the average atomic abundance of REE

in chondrites of all types; the abundance of heavy REE in H-group chondrites is somewhat higher than the abundance of REE in L-group chondrites and coincides with the average atomic abundance of REE in chondrites. (IAA)

**20751** COSMOGENIC $^{38}$Ar IN THE METALLIC PHASE OF CHONDRITES AND THEIR PRE-ATMOSPHERIC DIMENSIONS. Lavrukhina, A. K.; Fisenko, A. V.; Kolesnikov, E. M. (Inst. of Geochemical and Analytical Chemistry, Moscow). Meteoritika; No. 33, 58-60(1974). (In Russian).

**20752** COSMIC HISTORY OF THE SIKHOTS-ALIN METEORITE. Kolesnikov, E. M.; Lavrukhina, A. K.; Levskii, L. K.; Fisenko, A. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Meteoritika; No. 33, 105-108(1974). (In Russian).

The content of cosmogenic $^{39}$Ar, $^{38}$Ar, $^{21}$Ne, and $^{3}$He was determined in a number of specimens from the Sikhote-Alin' meteorite. The radiation ages of the various specimens, calculated from the $^{39}$Ar/$^{38}$Ar ratio, confirm the presence of two groups of maximum and minimum ages. It is probable that the parent body of the Sikhote-Alin' meteorite was formed about 450 m.y. ago. About 70 m.y. ago, this body underwent a destructive collision, which uncovered a fresh surface of the body. (IAA)

**20753** RESULTS OF A STUDY OF THE MALAKAL CHONDRITE /SUDAN/. El Rabaa, S. M. (Khartumskii Univ., Khartoum, Sudan); D'iakonova, M. I.; Kvasha, L. G. Meteoritika; No. 33, 83-89(1974). (In Russian).

The results of a complex investigation of a stony meteorite which fell in the beginning of August 1970 near the town of Malakal in the Sudan are given. It is established that this meteorite is a group-L crystalline chondrite which may be classed as a hypersthene-olivine chondrite. The Malakal meteorite is found to have undergone impact metamorphism which caused mechanical deformations, maskelynitization, partial recrystallization, and local melting. On the basis of the inert-gas isotope and $^{39}$Ar radioisotope concentrations, the radiation age of the meteorite is determined to be within the range from 2.4 to 4.4 m.y. The radiogenic age of the meteorite, as determined by the K–Ar method, is found to be 570 m.y. The low value of the radiogenic age is attributed to a loss of radiogenic gases. (IAA)

**20754** $^{14}$C IN IRON-BEARING METEORITES AND THE DETERMINATION OF THE AGE OF SPECIMENS FOUND ON EARTH. Alekseev, V. A.; Ivliev, A. I. (Inst. of Geochemical and Analytical Chemistry, Moscow). Meteoritika; No. 33, 47-48(1974). (In Russian).

**20755** NUCLEAR REACTIONS IN THE MATERIAL OF THE SOLAR SYSTEM. Lavrukhina, A. K.; Kuznetsova, R. I.; Rupp, E. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Meteoritika; No. 33, 14-22(1974). (In Russian).

The effects of nuclear reactions with fast protons at all stages of evolution of the material of the solar system are estimated. It is shown that nuclear reactions in stony meteorites caused by galactic cosmic rays cannot lead to a change in the primary isotopic composition of nonvolatile elements. Nuclear reactions with fast protons did not play a significant role in the formation of nuclides of solar-system material either at the stage of irradiation of the protosolar nebula by galactic cosmic rays or at the stage of irradiation of the protoplanetary cloud by solar protons during the period of differentiation of its chemical composition. It was found possible, for the first time, to reconcile observed abundances of light elements and bypassed nuclides with A less than 180 within the framework of a model of irradiation by protons in the hydrogen-rich material of a supernova shell. (IAA)

**20756** ORIGIN OF ISOTOPES OF PRIMORDIAL GASES. Levskii, L. K. (All-Union Scientific-Research Geological Inst., Leningrad). Meteoritika; No. 33, 23-29(1974). (In Russian).

The possibility is considered of determining the origin of primordial or trapped isotopes of inert gases on the basis of the relative atomic abundances of these isotopes. A previously established two-component atomic structure of primordial gases (Signer and Suess, 1963) is confirmed by a study of the isotopic composition of these gases in meteorites. A difference in the relative abundances of primordial gases of types A and B in meteorite material is noted, as well as different genetic origins of these gases. (IAA)

**20757** INTERPENETRATING SOLAR WIND STREAMS. Feldman, W. C.; Asbridge, J. R.; Bame, S. J.; Montgomery, M. D. (Los Alamos Scientific Lab., NM). Rev. Geophys. Space Phys.; 12: No. 4, 715-723(Nov 1974).

Observations of solar-wind interpenetrating ion streams are reviewed. They occur preferentially during periods of low but increasing plasma number density and most likely result from spatial and/or temporal inhomogeneities in the solar-wind bulk velocity. The exact nature of these inhomogeneities is not known, but three conceptual models that account for the observations are summarized. Double ion streams are shown to occur during extended time periods during which the proton anisotropy and dimensionless heat flux undergo large coherent variations. This fact provides strong evidence that a major source for solar-wind internal ion energy is its bulk convection energy. The observed continuum of proton velocity configurations further suggests that the ion internal energy state at 1 AU is often perturbed by bulk flow spatial and/or temporal inhomogeneities. Self-consistent interactions with the interplanetary wave mix that results from these inhomogeneities as well as other aspects of the solar-wind expansion establish preferred proton velocity configurations. These configurations can be summarized by simple statistical relations that couple the two independent third velocity moments to the second moments. (auth)

**20758** WAVES AND IRREGULARITIES IN THE SOLAR WIND. Lee, M. A.; Lerche, I. (Univ. of Chicago). Rev. Geophys. Space Phys.; 12: No. 4, 671-687(Nov 1974).

Some simple calculations are given to show why waves and irregularities in the solar wind are of importance in obtaining a physical understanding of the dynamical processes occurring in the interplanetary medium. The basic physics of divers phenomena observed in the heliosphere, resulting because of the presence of waves in the solar wind, is spelled out in some detail. The most fundamental point made is that a considerable body of phenomena occurring in the solar wind are either caused directly or modified significantly by the turbulent waves that are always present in the solar wind. Spacecraft data indicate the essentially continuous presence of strong magnetic irregularities in the solar wind, which, apparently, are predominantly Alfvén waves being convected outward from the Sun by the solar wind. The bulk dynamical properties of the wind are changed substantively by the waves and irregularities that the wind carries, this change leading, in particular, to higher solar wind speeds than occur in the absence of the waves. Also the observed spread of the 'frozen-in' field lines in the solar wind can be traced back to the random wanderings of the photospheric 'feet' of field lines emanating from the Sun. The observed variations in neutron monitor intensities and the low-energy particle fluctuations observed on Explorer 34 are accountable in terms of a 'slab' of material containing an irregular frozen-in magnetic field being convected past an observer. This field causes irregular fluctuations in the number of charged particles crossing the slab that are picked up by a detector. The detected irregularities are related to the irregularities in the 'slab', which also are measurable. The agreement is surprisingly good. The presence of magnetic irregularities and waves in the solar wind also causes scattering of cosmic-ray particles as they journey inward through the solar system from interstellar space. This leads to a modulation of the intensity of the cosmic rays seen at Earth. The relevant diffusion coefficients, conventionally used to describe this process, are expressible in terms of both the power spectra of the waves present in the solar wind and the charged particle parameters, such as speed, charge, and pitch angle. Although the main physical ideas incorporated into this process seem to be reasonably well understood, there remain an embarrassingly large number of unanswered questions concerning the details. (auth)

**20759** AUTOIONIZATION SPECTRA OF MAGNESIUM (Mg I, Mg II, AND Mg III) IN THE 50- TO 110-eV ENERGY RANGE. Esteva, J. M.; Mehlman, G. (CNRS, Meudon, France). Astrophys. J.; 193: No. 3, 747-753(1 Nov 1974).

A total of 68 resonances have been identified in the absorption spectrum of magnesium; 24 of them belong to the neutral atom and were almost entirely classified previously. 38 lines of singly ionized magnesium and a Rydberg series with six members corresponding to Mg III levels are reported for the first time. All upper levels involve inner-shell excitation of a 2p electron for Mg I and Mg II transitions and of a 2s electron for Mg III. Theoretical calculations involve extensive discussions of the electron coupling schemes for the Mg I and Mg II levels which do not retain an LS character because of the large spin-orbit interaction of the core. (auth)

**20760** MOST PRIMITIVE OBJECTS IN THE SOLAR SYSTEM. Grossman, L. Sci. Amer.; 232: No. 2, 30-38(Feb 1975).

Chrondite meteorites are discussed. Their mode of formation and chemical composition are considered in detail. It is noted that minerals found in the carbonaceous chondrites represent samples of the solid grains that condensed directly out of the gaseous nebula that gave birth to the sun and the planets. (JFP)

**20761** POSSIBLE INTERPRETATION OF AN ANOMALOUS REDSHIFT OBSERVED ON THE 2292 MHz LINE EMITTED BY PIONEER-6 IN THE CLOSE VICINITY OF THE SOLAR LIMB.

Merat, P. (Institut Henri Poincare, Paris); Pecker, J. C.; Vigier, J. P. Astron. Astrophys.; 30: No. 1, 167-174(Jan 1974).

An analysis of Goldstein's observations shows an anomalous redshift of the central frequency of the 2292 MHz band emitted by Pioneer-6 during its occultation by the Sun. This shift, symmetrical with respect to the Sun's center, does not correspond to any presently known physical effect. It can be quantitatively interpreted through an interaction between incident transverse photons and light neutral bosons emitted by the Sun, an interaction of the type proposed earlier by the authors. (auth)

**20762** OBSERVATIONS OF LINE 7892 A OF Fe XI BY MEANS OF PIC-DU-MIDI OBSERVATORY'S CORONAGRAPH. Noens, J. C.; Rozelot, J. P. (Observatories du Pic-du-Midi, Toulouse). Astron. Astrophys.; 30: No. 1, 81-85(Jan 1974). (In French).

A very few observations of the forbidden line 7892 Å of Fe XI have been made up to now. Some experimental results are described: isophotes maps, gradients, etc... They show that this line is rather intense, even in moderate periods of solar activity, as it was the case Dec 14, 1972. A complete theoretical study of Fe XI has been made in a separate paper, the results of which are taken here to compare with observational results. Concerning the line of sight, various assumptions are made which are discussed at each step of the calculus. Finally, a method is obtained which allows the computations of the characteristic sizes, the vertical density gradient and the electron density at the bottom of the studied structures. (auth)

**20763** SELF-LIMITING INVERSION TECHNIQUE FOR CENTER TO LIMB DATA. Holt, J. H. (Univ. of Queensland, Australia). Astron. Astrophys.; 30: No. 2, 185-188(Jan 1974).

A recently developed numerical technique for inverting a single absorption line profile is adapted to the inversion of center to limb data. Its performance is compared with that of the Prony algorithm for a set of synthetic observations. The method has the same ability to estimate the information about an atmosphere specified by the observations, but it does not require the observations to be specified at particular points. Also, the representation of the atmosphere is much better than the isothermal slabs obtained from the Prony algorithm. The results of the center to limb inversions of the mean sodium $D_2$ line at line-center and at 2.0 Å from line-center are compared to those from the single line inversion of the same line at disc center. (auth)

**20764** EFFECTS OF TURBULENCE ANISOTROPY ON PROPAGATION AND ELECTROMAGNETIC RADIATION OF PARTICLE STREAMS IN THE SOLAR CORONA. Heyvaerts, J.; de Genouillac, G. V. (Observatoire de Meudon, France). Astron. Astrophys.; 30: No. 2, 211-222(Jan 1974).

The evolution of a plasma-beam instability in the presence of nonlinear effects was studied. These consist of induced ll-scattering of Langmuir waves on the polarization clouds of ions; Langmuir waves are considered to have all possible angular patterns. This problem is set in relation to Type III solar radiobursts, hence the parameters used are those presumed to be characteristic of coronal conditions. Generally, the electromagnetic radiation of Type III bursts is attributed to the conversion of Langmuir waves. The nonlinear effects have been introduced in the literature as a mechanism for sustaining the streams of fast electrons or ions in which such plasma waves may originate. Langmuir turbulence anisotropy is explicitly taken into account as it may influence this stabilizing mechanism. Mathematical results show a saturation of the Langmuir turbulence due to nonlinear effects, but this regime is not acceptable from a physical point of view. To complete the study, the influence of the turbulence level and anisotropy on the electromagnetic radiation resulting from it by the two conversion processes usually invoked for Type III bursts are considered. Smith's result that the fundamental radiation could be amplified in the source is confirmed. (auth)

**20765** OGO-5 MEASUREMENTS OF THE LYMAN-ALPHA SKY BACKGROUND IN 1970 AND 1971. Thomas, G. E.; Krassa, R. F. (Univ. of Colorado, Boulder). Astron. Astrophys.; 30: No. 2, 223-232(Jan 1974).

The Lyman-alpha sky background emission at 1216 Å was mapped three times in 1969 and 1970, and three additional times in 1970 and 1971 by the OGO-5 ultraviolet photometer experiment. The results from the last three "spin-up" (SU) maneuvers are reported. (WDM)

**20766** MASS TRANSPORT INDUCED BY TIME-DEPENDENT OSCILLATIONS OF FINITE AMPLITUDE IN A STRATIFIED PERFECT GAS. Tjoetta, J. N.; Tjoetta, S. (Univ. of Bergen). Astron. Astrophys.; 30: No. 2, 249-258(Jan 1974).

The mass transport induced by time-dependent oscillations of finite amplitude in a stratified gas is considered. The mass transport is given by the Lagrangian mean velocity, calculated to the second order in the Mach number of the oscillations. No mass transport is found in a nondissipative model. Taking into account dissipation, however, the theory leads to nonzero vertical drift and horizontal flow. The vertical drift becomes zero in an incompressible model. The general theory is applied to study the flow in the solar atmosphere. (auth)

## Galaxies

*Refer also to abstracts 19287, 20683, 20709, and 20725.*

**20767** ABUNDANCE OF INTERSTELLAR BERYLLIUM. Boesgaard, A. M. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 34: No. 1, 9-13(Aug 1974).

The results of a search for interstellar Be from the Be II resonance lines at λλ 3130, 3131 in 22 O and B stars are reported. Spectrograms at 3.4 Å/mm for 19 stars and at 6.7 Å/mm for 3 stars were obtained at the 224-cm telescope at Mauna Kea. Upper limits for the equivalent width of a Be II line gives the maximum Be column densities. These are compared directly with Ly-α measures of interstellar H I, where available. In other cases the Ca II doublet ratio method and the interstellar average Ca II/H I value give the Be/H I ratio. The lowest limit on Be/H I found is $\leq 4 \times 10^{-11}$. The four stars with the smallest ratio give an average Be/H I $\leq 7 \times 10^{-11}$. These numbers are comparable to the Be/H ratio found in dwarf G stars. Large molecular hydrogen contents, as indicated by high (B−V) excesses for some of the stars imply that the corrected interstellar Be/H ratio may be 2 to $3 \times 10^{-11}$. The corrected average Be/H for seven stars is $\leq 5 \times 10^{-11}$. (auth)

**20768** NEUTRAL HYDROGEN STUDY OF SPIRAL AND IRREGULAR DWARF GALAXIES. Balkowski, C.; Bottinelli, L.; Chamaraux, P.; Gouguenheim, L.; Heidmann, J. (Observatory, Meudon, France). Astron. Astrophys.; 34: No. 1, 43-52(Aug 1974).

21-cm measurements of 13 dwarf galaxies of irregular and spiral types outside the Local Group were carried out with the Nançay radiotelescope. Systematic errors on their apparent magnitudes are discussed. The dwarf galaxies have small internal velocity dispersions and relatively high values of their hydrogen mass to luminosity ratios. This fits the two-parameter (type and luminosity) classification of galaxies. Comparison with the blue dwarfs give support to Searle, Sargent, and Bagnuolo's model according to which the dwarf galaxies correspond to a quiescent phase of the blue ones. (auth)

**20769** INTERPRETATION OF THE KINEMATICS OF THE LOCAL INTERSTELLAR NEUTRAL HYDROGEN AS INDICATIVE OF A SEPARATE SUBSYSTEM. Burton, W. B. (National Radio Astronomy Observatory, Charlottesville, VA); Bania, T. M. Astron. Astrophys.; 34: No. 1, 75-79(Aug 1974).

Some aspects of the velocity behavior of the local low-latitude neutral hydrogen gas are discussed for a situation in which the observer is immersed in a flow pattern of the sort predicted by the linear density-wave theory. Model line profiles calculated using such a velocity-field show characteristics of the observed hydrogen kinematics which have previously been interpreted in terms of a separate subsystem. (auth)

**20770** WOLF-RAYET STARS IN THE GALACTIC WINDOW AROUND l = 307°. Lynga, G.; Stenholm, B. (Lund Observatory, Sweden). Astron. Astrophys.; 31: No. 1, 111-112(Feb 1974).

Around l = 307° there are several WR stars at large distances with unexpectedly low color excesses. This is suggested to be due to a gap between spiral arms, a galactic window. (auth)

**20771** OH ABSORPTION AGAINST THE CARINA NEBULA. Dickel, H. R.; Wall, J. V. (CSIRO, Sydney). Astron. Astrophys.; 31: No. 1, 5-10(Feb 1974).

A map of the 1667 MHz OH absorption against the Carina nebula was obtained with the Parkes 64-m telescope; the OH molecules are in two concentrations, neither of which is centered on the continuum peak of the nebula. Comparisons of these observations both with 4830 MHz $H_2CO$ absorption and with optical absorption indicate that the OH and $H_2CO$ molecules are closely associated with the dust obscuring the nebula. (auth)

**20772** CARINA NEBULA: A POSSIBLE INTERPRETATION OF THE MOLECULAR OBSERVATIONS. Dickel, H. R. (Univ. of Illinois Observatory, Urbana). Astron. Astrophys.; 31: No. 1, 11-16(Feb 1974).

A model is put forward to interpret the observations of the molecules in the direction of the Carina nebula. Previously it was found that the $H_2CO$ and the OH absorption is concentrated

toward the positions of the two optically prominent dust lanes that cross the nebula. In this paper the visual absorption is mapped and it is shown that the concentrations of dust, molecules, and neutral hydrogen are probably located at the H II region. The observed pattern of molecular radial velocities can be interpreted by an outward expansion from the H II region at a rate of about 7 km $s^{-1}$. If this is the case, then the density enhancement in this expanding shell is found to be ~150 by application of the conservation laws at the resultant isothermal shock front. Values for the thickness, density, and the mass of the various components of the Carina nebula are estimated from neutral hydrogen observations. (auth)

**20773** INTERSTELLAR LINES IN THE SOUTHERN HEMISPHERE. Rickard, J. J. (European Southern Observatory, Santiago, Chile). Astron. Astrophys.; 31: No. 1, 47-61(Feb 1974).

Observations of more than 300 interstellar K-line components seen in 168 southern stars were examined for information about galactic structure and turbulent motions in the interstellar gas. The data of several observers are analyzed together with new observations of 67 stars by the author. A catalog of interstellar lines, including data relevant to the stars, is presented. (WDM)

**20774** APERTURE SYNTHESIS STUDY OF H I IN THE GALAXY IC 10. Shostak, G. S. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 31: No. 1, 97-101(Feb 1974).

Synthesis observations of the neutral hydrogen in the partially obscured, irregular galaxy IC 10 are presented. Angular resolution is 2′ arc and spectral resolution is 21 km $s^{-1}$. The data are consistent with a flattened gas distribution undergoing general rotation. Morphology of the H I distribution is similar to that of the Small Magellanic Cloud. IC 10 is approximately 3 times as massive as the SMC. Evidence is presented which suggests that the obscuration in the direction of IC 10 has been overestimated. (auth)

**20775** RR LYRAE STARS IN THE LARGE MAGELLANIC CLOUD CLUSTER NGC 1835. Graham, J. A. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Ruiz, M. T. Astron. J.; 79: No. 3, 363-367(Mar 1974).

The globular cluster NGC 1835 in the Large Magellanic Cloud is shown to be very rich in variable stars of the RR Lyrae type. Periods and mean blue magnitudes are given for 18 variables, 11 of type ab, and seven of type c. The period distribution is characteristic of an Oosterhoff Type I cluster. (auth)

**20776** PHOTOMETRY OF STARS IN THE NUCLEAR BULGE OF THE GALAXY THROUGH A LOW-ABSORPTION WINDOW AT $l = 0°$, $b = -8°$. van den Bergh, S.; Herbst, E. (Univ. of Toronto). Astron. J.; 79: No. 5, 603-615(May 1974).

A color–magnitude diagram down to $V \sim 20$ has been obtained in a low-absorption window at $l = 0°$, $b = -8°$. This color–magnitude diagram shows the following: (1) Red giants of Population II suddenly appear in large numbers at $V \simeq 13.3$; (2) Very metal-poor red giants are, however, quite rare at $|Z| \simeq 1.3$ kpc; (3) A distinct stratification effect occurs in the nuclear bulge. Metal-rich red giants are more common at $|Z| \simeq 0.6$ kpc than they are at $|Z| \simeq 1.3$ kpc. The opposite effect is found for metal-poor Population II giants; and (4) "super-metal-rich" stars are probably rare or absent in the nuclear bulge at $|Z| \cong 1.3$ kpc. Photoelectric observations of distant RR Lyrae variables yield $E_{B-V} = 0.25 \pm 0.05$. With this reddening value, the distance to the nuclear bulge becomes $9.2 \pm 2.2$ kpc. (auth)

**20777** OBSERVATIONS OF HI IN DENSE INTERSTELLAR DUST CLOUDS. I. A Survey of 88 Clouds. Knapp, G. R. (Univ. of Maryland, College Park). Astron. J.; 79: No. 5, 527-540(May 1974).

A large number of interstellar dust clouds, with various values of visual absorption, was surveyed in the 21-cm line of neutral hydrogen using high-velocity resolution, in a search for narrow absorption lines in the HI emission profiles which could be attributed to the presence of cold HI in the dust clouds. It was found that somewhat less than half of the dust clouds observed were associated with such self-absorption dips and that the greater the observed optical density of the clouds, the greater their chance of showing up in self-absorption. The radial velocities of this group of dust clouds were used to study the kinematics of the local dust cloud population. It was found that the radial velocities of the dust clouds are very close to the HI peak emission velocities in the same directions, showing that the dust clouds are part of the general local system of interstellar matter. The observations were analyzed using simple models for the density and temperature distribution of the atomic hydrogen in the dust clouds. These calculations showed that the HI velocities are very close to the OH and $H_2$ CO velocities, and that the mean excitation temperature of the HI in the observed dust clouds ranges from 16°K to 40°K; these are much higher values than those found for the molecules in dust clouds. The calculated central optical depths of the clouds are found to range between about 0.5 and 4.0 and the calculated HI column densities, generally a few times $10^{20}$ atm $cm^{-2}$, have only about 1 to 5% of the values predicted from the OH or dust column densities, so that much of the hydrogen in dense interstellar dust clouds must be in some form other than HI, most probably $H_2$. The line shapes for several of the HI clouds are suggestive of the presence of systematic expansion or contraction motions. For all such clouds, the line shapes are consistent with a model of a contracting cloud slightly hotter at the center, suggesting that the clouds are in a fairly advanced stage of collapse. (auth)

**20778** OBSERVATIONS OF HI IN DENSE INTERSTELLAR DUST CLOUDS. II. The Cloud Khavtassi 3. Knapp, G. R. (Univ. of Maryland, College Park). Astron. J.; 79: No. 5, 541-554(May 1974).

High-frequency-resolution HI observations of the dark cloud Khavtassi 3 show that the HI in the cloud, seen as a narrow self-absorption component at +13 km/sec, correlates well in position with the darkest parts of the cloud. The HI column density is highest where the dust is darkest, which implies that the HI is distributed throughout the cloud. Simple models of the HI distribution in the cloud, combined with the absorption profile for the continuum source W44, which is behind Kh 3, show that the neutral atomic hydrogen in this cloud is less than 1% of the total hydrogen content of the cloud. Several other self-absorption features were found in the observations, corresponding to HI clouds at different velocities and distances along the line of sight. An HI cloud at +30 km/sec was mapped; in this cloud the relative abundance of HI is considerably higher than it is in the +13 km/sec cloud. Other clouds at velocities of +7, +22, +38, +45, and +81 km/sec were also found. Several of these clouds have a patchy structure. The cloud at +45 km/sec (the velocity of W44) forms a ring around W44. (auth)

**20779** CORRELATION STUDY OF CARBON IONS AND HYDROXYL MOLECULES TOWARD GALACTIC NEBULAE. Chaisson, E. J. (Smithsonian Astrophysical Observatory, Cambridge, MA). Astron. J.; 79: No. 5, 555-564(May 1974).

New observations of the C 92a recombination line and of the $^2\pi_{\frac{1}{2}}$, $J = \frac{1}{2}$ rotational transition of OH are reported in the direction of the five strongest carbon-line sources: W3A, W10, W12, W22, and W51A. For every carbon line, there is an OH absorbing feature with a very similar radial velocity; a linear-regression analysis yields a correlation coefficient of 0.999. The widths of the velocity correlated features are also related. The functional form of the linewidth relation suggests a separation of the carbon ions (at the periphery) and the OH molecules (in the core) within the predominantly neutral region. Depletion of charged-particle abundance in the region of the OH molecules allows the short-range collisional excitation rate W(OH-neutrals) to dominate the longer range rate W(OH-ions). For total densities $n(H + 2H_2) \gtrsim 10^{15}/cm^3$, the excitation of the Λ-doublet state of the OH molecule remains largely unresponsive to radiative processes. For the shielded, central cores of the predominantly neutral regions, it is concluded that the kinetic temperature of the OH molecules must be ~5°K, considerably less than the canonical value of 30 to 100°K usually employed. (auth)

**20780** WAVELENGTH DEPENDENCE OF POLARIZATION. XXV. Rotation of the Position Angle by the Interstellar Medium. Coyne, G. V. (Univ. of Arizona, Tucson). Astron. J.; 79: No. 5, 565-580(May 1974).

Multicolor polarimetric data are given for 105 early-type stars. These data plus those previously published in this series of papers are analyzed with respect to the rotation of the position angle of the the interstellar polarization with wavelength. Altogether, 24 stars (13% of those measured in the northern hemisphere) for which the polarization is predominately interstellar show this effect. The observations support the explanation previously proposed of a change both in the direction of grain alignment and in grain size along the line of sight to those stars. Ten stars for which interstellar circular polarization has been measured support this model as does the study of circular interstellar polarization in the direction of the Crab Nebula. The small percentage of stars which show the rotation effect suggests that the combination of anomalies in the magnetic field and in particle size is not encountered very frequently in the Galaxy. (auth)

**20781** WAVELENGTH DEPENDENCE OF POLARIZATION. XXVI. The Wavelength of Maximum Polarization as a Characteristic Parameter of Interstellar Grains. Coyne, G. V.; Gehrels, T.; Serkowski, K. (Univ. of Arizona, Tucson). Astron. J.; 79: No. 5, 581-589(May 1974).

A unique representation of the wavelength dependence of the interstellar polarization is obtained by using the parameter $\lambda_{max}$,

which is the wavelength at which the maximum polarization $p_{max}$ occurs, to normalize the wavelengths at which the observations are made. Values of $\lambda_{max}$ and $p_{max}$ are given for all 202 stars for which measures of the interstellar polarization have been made at the University of Arizona. The observed normalized wavelength dependence of interstellar polarization is compared to that predicted by some classical models of the interstellar grains. The observations agree with models that employ dielectric cylinders and the Davis–Greenstein orientation mechanism, but other models must still be tried. (auth)

**20782** WAVELENGTH DEPENDENCE OF POLARIZATION. XXVII. Interstellar Polarization from 0.22 to 2.2 $\mu$m. Gehrels, T. (Univ. of Arizona, Tucson). Astron. J.; 79: No. 5, 590-593(May 1974).

The linear polarization of $\zeta$ Oph was observed at 0.225 and 0.286 $\mu$m with a balloon telescope, between 0.3 and 1.0 $\mu$m with standard equipment, and at 1.6 and 2.2 $\mu$m with a new infrared polarimeter. A measurement of $\kappa$ Cas at 0.225 $\mu$m is also reported. A comparison of $\gamma$ Cas, a Be star showing a marked polarization–wavelength dependence due to hydrogen absorption, is made with $\kappa$ Cas which probably shows mostly interstellar polarization. Because the interstellar polarization and reddening are primarily diffraction phenomena, they are good indicators of particle size, but not of refractive index. (auth)

**20783** MODELS OF MASSIVE MOLECULAR CLOUDS. Zuckerman, B. (University of California, Berkeley); Evans II, N.J. Astrophys. J. Lett. 192: No. 3, L149-L152 (15 Sept 1974).

Observations of carbon monoxide lines from massive molecular clouds, such as those near Orion A and Sgr B2, have recently been interpreted in terms of large–scale motions, generally collapse or expansion, that imply rapid evolution of these clouds. We suggest an alternative explanation: the clouds are not dominated by large–scale systematic motions and the CO profiles are determined primarily by local motions. Therefore, it is generally not possible to see through these clouds in optically thick lines of molecules such as CO and HCN. Some consequences and tests of this model are briefly discussed. (auth)

**20784** A NEW DCN LINE: DCN(HCN) EXCITATION. Phillips, T.G.; Jefferts, K.B. (Bell Laboratories, Murray Hill, New Jersey); Wannier, P.G. Astrophys. J. Lett. 192: No. 3, L153-L156 (15 Sept 1974).

We report the observation of the J=3–2 line of DCN in the Orion Nebula and show that a simple excitation model accounts for the ratios of the J=1–0, 2–1, and 3–2 antenna temperatures. Comparison of observation and theory determines the scattering rate for DCN and HCN at the Orion Nebula molecular peak. (auth)

**20785** COUNTS OF GALAXIES IN SEVEN DISTANT CLUSTERS. Noonan, T. W. (Brockport State College, NY). Astron. J.; 79: No. 3, 358-362(Mar 1974).

Counts of galaxies in each of seven distant clusters with redshifts between 0.17 and 0.46 are presented. Luminosity segregation is found in two of the clusters. The data is inconclusive as regards color segregation. (auth)

**20786** OBSERVATIONS OF ABELL CLUSTERS OF GALAXIES AT 1400 MHz. Owen, F. N. (Univ. of Texas Radio Astronomy Observatory, Austin). Astron. J.; 79: No. 4, 427-436(Apr 1974).

Observations are reported of 503 Abell clusters of galaxies at 1400 MHz with a limiting flux density of 0.10 f.u. [1 f.u. = 1 Jansky = $10^{-26}$ $wHz^{-1}m^{-2}$]. A total of 259 sources were detected within one Abell cluster radius. Contour maps are presented for 20 clusters. Three of the most interesting are discussed in more detail. (auth)

**20787** MODELS OF A LONGITUDE-DEPENDENT GALACTIC ABSORPTION. d'Occhieppo, K. F.; Jenkner, H. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl.; 181: No. 4-7, 157-173(1973). (In German).

A number of models were constructed which illustrate the effect of the nonrandom distribution of interstellar matter near the galactic plane on photometric distance determinations. Two models were constructed which correspond to the usual assumption that the absorbing clouds are concentrated in spiral arms marked by clusters and associations of young stars. In one of them the spiral arms are assumed to be straight, while in the other the spiral arms are assumed to have a parabolic curvature. A third model is constructed which corresponds to the assumption that the absorbing material accumulates preferentially along the inner edges of bright spiral arms. (IAA)

**20788** STABILITY OF GALAXY CLUSTERS: NEUTRAL HYDROGEN OBSERVATIONS. De Young, D. S.; Roberts, M. S. (National Radio Astronomy Observatory, Charlottesville, VA). Astrophys. J.; 189: No. 1, 1-9(1 Apr 1974).

New upper limits are obtained for the 21-cm emission from the Cancer, Coma, Pegasus 1, and Perseus clusters of galaxies. In all cases these limits correspond to a galactic mass (~$10^{11}$ $M_\odot$) of optically thin neutral hydrogen. These observations rule out the possibility that the Coma cluster is gravitationally bound by rotationally supported, optically thick clouds of neutral hydrogen. The conclusion concerning the remaining clusters is less certain, and more optical and radio data are needed. (auth)

**20789** REMARKS ON THE MAGNITUDE–REDSHIFT BANDS IN THE COMA CLUSTER. Barnothy, J. M.; Barnothy, M. F. Astrophys. J.; 189: No. 1, 11-16(1 Apr 1974).

The band pattern found by Tifft in the magnitude–redshift diagram of the galaxies in the Coma cluster has no statistical significance, and could be caused by a random variation in the velocity and apparent magnitude of the objects. The apparent–magnitude histogram of the galaxies closer than 0.2° to the center of the cluster, indicates the presence of a central absorbing cloud. Such a cloud, if present in clusters, could produce a band pattern in the m–v diagram, consisting of three quasi-parallel bands, spaced 0.5 to 0.7 mag apart. The banding pattern can therefore be understood in the frame of accepted statistical or physical laws, without the need to stipulate an intrinsic redshift, or other novel physical phenomena. (auth)

**20790** GASEOUS FLOWS IN DISK GALAXIES. Saaf, A. F. (Michigan State Univ., East Lansing). Astrophys. J.; 189: No. 1, 33-38(1 Apr 1974).

The equations of motion and continuity which determine the structure of the gaseous component of a thin disk galaxy have been studied for the case in which the spiral structure is stationary in a coordinate system rotating with the spiral pattern. The solution depends on a Fourier analysis of the relevant physical quantities in the angular coordinate, and approximate solutions are presented for both the $2\theta$ and $4\theta$ modes. It is necessary to assume that a parameter of smallness $\epsilon$ can be associated with each Fourier mode, and that terms of order $\epsilon^2$ or higher can be ignored in equations of order unity. In this sense, the solutions are approximate; and as one would expect, the solutions for the $2\theta$ mode coincide with the hydrodynamical results of the purely linearized theory of Lin and Shu. (auth)

**20791** TURBULENCE-ENHANCED SYNCHROTRON RADIATION IN THE GALAXY. Cowsik, R.; Mitteldorf, J. (Univ. of California, Berkeley). Astrophys. J.; 189: No. 1, 51-53(1 Apr 1974).

The intensity of synchrotron radiation from the galactic disk depends both on the magnetic field strength and on the density of the cosmic-ray electrons. Evidence based on Faraday rotation of pulsar signals indicates that the average galactic magnetic field $B_0$ is ~ 3 microgauss with fluctuations $\Delta B$ of the same order of magnitude. In this field cosmic-ray electrons with the same density as that observed near the solar system produce insufficient synchrotron radiation to account for the galactic radio background. Indeed, one needs either average fields of ~ 10 microgauss or about 10 times the cosmic-ray fluxes to generate the observed radio intensities. Such high magnetic fields or cosmic-ray densities can be excluded by several arguments, including one given by Parker involving the force balance between their pressure gradient and the gravitational forces on the ambient interstellar gas. If, however, the magnetic field fluctuations arise because of compressions of the average fields by motions of the interstellar gas, then betatron processes induce a correlated increase of the relativistic electrons in the high field regions. The average synchrotron emissivity nonlinearly increases to make the estimated emissivities compatible with radio-astronomical data. (auth)

**20792** STATISTICAL TIME-DEPENDENT MODEL FOR THE INTERSTELLAR GAS. Gerola, H.; Kafatos, M.; McCray, R. (Univ. of Colorado, Boulder). Astrophys. J.; 189: No. 1, 55-66 (1 Apr 1974).

Models are presented for temperature and ionization structure of low, uniform-density ($n \simeq 0.3$ $cm^{-3}$) interstellar gas in a galactic disk which is exposed to soft x rays from supernova outbursts occurring randomly in space and time. The structure was calculated by computing the time record of temperature and ionization at a given point by Monte Carlo simulation. The calculation yields probability distribution functions for ionized fraction x, temperature T, and their various observable moments. These time-dependent models predict a bimodal temperature distribution of the gas with structure in x, T that agrees with various observations. Cold regions in the low-density gas may have the appearance of clouds in 21-cm absorption. The time-dependent model, in contrast to the steady-state model, predicts large fluctuations in ionization rate and the existence of cold ($T \simeq 30°$ K), ionized ($x \simeq 0.1$) regions. (auth)

**20793** IONIZATION OF COOL H I REGIONS. Steigman, G. (Yale University, New Haven); Kozlovsky B. Z.; Rees, M. J. Astron. Astrophys.; 30: No. 1, 87-93(Jan 1974).

The diffuse, soft ($E \gtrsim 0.3$ keV) x-ray flux contributes significantly to the ionization of atoms and ions in the interstellar medium. Ionizations by such photons primarily create inner shell vacancies which are filled mainly via Auger emission. As a result, even in cool H I regions ions such as C IV and N III should be sufficiently abundant to be detectable. Attention is restricted to the ionization of carbon and nitrogen in typical interstellar clouds. Softer x rays ($E \lesssim 0.3$ keV) are attenuated and do not penetrate such clouds. Hence the important effects of an unknown flux of very soft x rays whose intensity would be expected to vary from place to place within the Galaxy is minimized. By choosing carbon and nitrogen and their ions, the importance of K-shell ionizations compared to outer shell ionizations which are not followed by Auger emission are maximized. The ionization due to a large flux of low-energy cosmic rays ($E \approx 1-10$ MeV) is computed. By observing the ratios C IV/C III and N III/N II in interstellar clouds one may determine whether ionization by cosmic rays is important. The electron density in clouds may be determined from observations of the ratios C IV/C II and N III/N I. If charge exchange reactions are important, the presence of N II will be suppressed and N III > N II. (auth)

**20794** NATURE OF THE NONTHERMAL RADIO EMISSION FROM THE GALACTIC CENTER. Jones, T. W. (Univ. of California, San Diego). Astron. Astrophys.; 30: No. 1, 30-37(Jan 1974).

Early radio observations of the galactic center resulted in the identification of Sgr A as a strong radio source with a steep nonthermal spectrum. Subsequent observations left the picture less clear, with the spectrum apparently much flatter ($\alpha \simeq 0.25$). The lack of significant polarization and the radio-infrared luminosity ratio are consistent with the source being thermal. In this paper, it has been shown, however, when the most recent observations at low and high frequencies are included, and the multiple nature of Sgr A are accounted for, the principal source has a definitely nonthermal shape with spectral index $\alpha \simeq 0.4-0.5$. It is further argued that, on the basis of its general appearance, energetics and recent observations which no longer put Sgr A exactly at the galactic center, Sgr A could be a supernova remnant near the galactic center rather than a miniature of energetic extragalactic sources. (auth)

**20795** STELLAR STABILITY FOR DISTRIBUTION FUNCTION "HOLES" IN PHASE SPACE. Bloomberg, H. W. (College of William and Mary, Williamsburg, VA). Astron. Astrophys.; 30: No. 1, 59-66(Jan 1974).

The stability of a one-dimensional stellar system, where the interactions are collective, is considered. Eigenmode equations for a double water bag configuration are solved for the case that the distribution function inside the inner (lower energy) bag is less than it is outside the bag. An overstability is found to exist for equilibria where the period of particles on the outer contour is nearly equal to the period of particles on the inner contour. The instability occurs at integer values of the particle excursion frequencies. Expressions are derived for the dependence of the growth rate on the equilibrium configuration. (auth)

**20796** INTERACTION OF HOT STARS AND OF THE INTERSTELLAR MEDIUM. IV. Two Bright H $\alpha$-Knots Associated With the H II Region Sharpless 88. Lortet-Zuckermann, M. C. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 30: No. 1, 67-72(Jan 1974).

Two bright H$\alpha$-knots near the diffuse nebula Sharpless 88 are described. They both contain one or two central stars, one of which has been found from UBV photometry to be a reddened blue star. Attention is drawn to the relative positions of these knots, a closeby OH source and two radio continuum sources, all located in an obscured region definitely distinct from the more extended optical nebula Sharpless 88. The observed region appears to be a favorable region for star formation. (auth)

**20797** MOTIONS OF SATELLITES ASSOCIATED WITH LARGE SPIRAL SYSTEMS. Lauberts, A. (Astronomical Observatory, Uppsala). Astron. Astrophys.; 30: No. 1, 73-80(Jan 1974).

A study of the orbital kinematics of satellites moving in the gravitational field of a prominent spiral galaxy is described. As a typical model of a large spiral system, our own Galaxy has been chosen. The satellites are assumed to possess small masses with negligible reactions on the central galaxy. Different hypotheses have been considered in order to explain a pronounced polar oriented distribution of apparent position angles. Special attention has been devoted to the hypothesis of mass ejections in roughly the polar directions from the nucleus of the parent system. In the course of time, however, the radial-type orbits degrade to lower latitudes, the rate depending on the orbital periods of the ejected bodies. Because this behavior throws severe doubts on the ejection idea, a more conventional orbital geometry has also been considered, in which the satellites are moving in somewhat less elongated, but stable, elliptical orbits. (auth)

**20798** EXTINCTION BY INTERSTELLAR RADICALS. Andriesse, C. D.; de Vries, J. (Kapteyn Astronomical Inst., Groningen, Netherlands). Astron. Astrophys.; 30: No. 1, 51-58(Jan 1974).

The scattering by interstellar free radicals (Platt's particles) is calculated. The results are applied to interpret recent data on the far-ultraviolet extinction, which apparently is due to scattering rather than absorption processes. The calculation is based on two one-dimensional models of free electrons confined to a small box with size R, the first with an infinite- and the second with a finite binding potential $U_0$. An exact analytic treatment is given for the first model and an approximative treatment for the second model based on a perturbation calculation. We derive transition frequencies and—probabilities between the ground—and the first excited state as a function of the model parameters R and $U_0$. Using two plausible distribution functions for the size of interstellar radicals, continuous extinction spectra, made up of distinct quantum transitions within individual radicals, are calculated. A possible fit is shown to extinction data for $\zeta$ Per below 1600 Å. From this fit follows a mean radical size of about 10 Å and a density of 10 $m^{-3}$, which appear reasonable numbers. It is concluded that scattering by free electrons in rather small radicals can account for the observed far-ultraviolet extinction and the high albedo. It is conjectured that bonding electrons in the same particles are responsible for the visual- and near-ultraviolet extinction. (auth)

**20799** OPTICAL AND 21-CM LINE SPECTROSCOPIC STUDIES OF SOME COMPACT GALAXIES. Carozzi, N. (Observatoire de Marseille); Chamaraux, P.; Duflot-Augarde, R. Astron. Astrophys.; 30: No. 1, 21-29(Jan 1974).

Spectra of two blue compact galaxies (VII Zw 403 and VII Zw 301) and of two blue galaxies with compact parts (NGC 4861 and I Zw 41) were obtained; all of them show emission lines. NGC 4861 appears as a normal rotating late-type galaxy, as previously stated by de Vaucouleurs, G and de Vaucouleurs, A.; in particular, its H I content is in agreement with this morphological type. The compact part could be a supergiant H II complex. In the double galaxy I Zw 41 evidence is obtained of rotation in the southern component while no significant redshift difference is observed between the two members. The 21-cm measures show that most of the mass of I Zw 41 is in the form of neutral hydrogen, as in other previously detected compact galaxies. VII Zw 301 has the mean characteristics of the class of the compact galaxies with emission lines described by Sargent. Lastly, VII Zw 403 is found to have a slight blueshift of $-110$ km $s^{-1}$. The characteristics of its spectrum, particularly the evidence for absorption lines and the strength of the continuum seem to rule it out as a galactic object. It should perhaps be attributed to the class of dwarf compacts surveyed by Arp and Sargent. (auth)

**20800** EVOLUTION OF THE NEARBY STELLAR POPULATION AND ITS KINEMATICS. Biermann, P. (Columbia Univ., New York); Tinsley, B. M. Astron. Astrophys.; 30: No. 1, 1-12(Jan 1974).

Following the discovery of a great number of low-velocity M dwarfs (Weistrop, 1972 and others), Biermann (1973) formulated the idea that the velocity dispersions of stars are a property largely given to the stars at formation and modified over galactic time-scales. Using these ideas and the formalism of Tinsley (1972), a quantitative model of the stellar population in the solar neighborhood is investigated which includes the evolution of stellar kinematics. The model is able to account for all major properties of the stellar disk population (halo stars excluded). The tentative conclusion is drawn that the spiral arm inclination and/or shock strength was considerably greater in the past history of the Galaxy. (auth)

**20801** DENSITY-WAVE THEORY OF SPIRAL STRUCTURE. Rohlfs, K. (Max-Planck-Institut fuer Radioastronomie, Bad Godesberg, Ger.). Sterne Weltraum; 13: 114-118(Apr 1974). (In German).

The new theory regarding the mechanics involved in the formation of the spiral structure of a galaxy was developed by Lin (1970) with the aid of the approaches of modern stability analysis. The only forces considered by the density-wave theory are the gravitational forces exerted by the stars and the interstellar medium. The characteristics of the gravitational forces in the galaxy are examined, taking into account a modernized version of a model investigated by Schmidt (1956). Possible perturbations of the gravitational potential are discussed together with aspects of a spiral shock wave theory. (IAA)

**20802** COMPACTNESS AND REDSHIFTS OF COMPANION GALAXIES MEMBERS OF GROUPS OF GALAXIES. Collin-Souffrin, S. (Observatoire de Meudon, France); Pecker, J. C.; Tovmassian, H. M. Astron. Astrophys.; 30: No. 2, 351-352(Jan 1974).

In groups of galaxies, although the brightest galaxy of the group has often a compact nucleus, the companion galaxies are more clearly redshifted when they are a compact nucleus themselves. Although the sample of galaxies studied in this paper is rather limited, it seems that compactness, altogether, favors redshift. (auth)

**20803** STATISTICAL MODEL FOR INTERCLOUD H I-GAS. I. Theory. Mebold, U.; Hachenberg, O.; Laury-Micoulaut, C. A. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 30: No. 2, 329-338(Jan 1974).

The small scale fluctuations observed in the emission of the intercloud H I-gas have been explained in the literature by a gas model in which this gas is composed of a large number of turbulence cells which are randomly distributed in space and velocity. In the present paper analytical formulae are derived from which the most interesting parameters of the proposed model can be derived. An application of these formulae to publish data shows that these data are not accurate enough to give significant results for the parameters—especially the kinetic temperature—of the observed gas. (auth)

**20804** SEARCH FOR GAMMA-RAY EMISSION FROM THE GALACTIC ANTI-CENTER REGION. Forichon, M. (CEN, Saclay, France); Agrinier, B.; Leray, J. P.; Parlier, B.; Boella, G.; Maraschi, L.; Buccheri, R.; Sacco, B.; Scarsi, L. Astron. Astrophys.; 30: No. 2, 323-327(Jan 1974).

The analysis procedure and the results of a search for discrete gamma-ray sources (E > 20 MeV) in the galactic-anti-center region, carried out in the years 1969–70–71 with a balloon flown spark chamber telescope, are reported. Except for the Crab Nebula, whose flux was found to be (E > 20 MeV) = $9 \pm 3.5 \times 10^{-5}$ ph/cm$^2$ s, no other gamma-ray source was observed. Upper limits are given for the gamma-ray emission above 20 MeV of the objects in the observed sky region which have been reported as gamma-ray sources (Pe – $\gamma$1, 3C 120, galactic disc). (auth)

**20805** THERMAL AND IONIZATION EQUILIBRIUM OF AN X-RAY HEATED INTERCLOUD MEDIUM. Grewing, M. (Univ., Bonn); Walmsley, C. M. Astron. Astrophys.; 30: No. 2, 281-287 (Jan 1974).

New x-ray measurements were used to compute the ionization equilibrium of the heavy elements in the intercloud gas. The results are compared with ultraviolet observations from the Copernicus satellite. It is found that a hot intercloud medium of density 0.2 cm$^{-3}$ is compatible with the x-ray results if depleted intercloud abundances derived from the ultraviolet observations are used. The ionization equilibrium predicted on this basis is in contradiction with observations only in the case of nitrogen. (auth)

**20806** INTERACTION OF HOT STARS AND OF THE INTERSTELLAR MEDIUM. V. The Compact Optical Regions Sharpless 255, 257, and 269. Chopinet, M.; Deharveng-Baudel, L.; Lortet-Zuckermann, M. C. (Observatoires de Bordeaux, Marseille). Astron. Astrophys.; 30: No. 2, 233-240(Jan 1974).

H$\beta$ photographs obtained using a Lallemand electronic camera, low-dispersion spectra in the range 4300 to 7300 Å and high-dispersion spectra near H$\alpha$ were obtained for three galactic nebulae. The excitation of these nebulae is low, the electron densities and reddening are moderate. The densest regions (up to 1000 or 3000 electrons per cubic centimeter) generally are associated with abrupt brightness variations. The H$\alpha$ radial velocity field of Sh 2-255 and the identification of the exciting star of Sh 2-269 are discussed. All three nebulae, as inferred from their relatively high density and from their association with OH and $H_2O$ sources might represent an early stage of evolution of H II regions. (auth)

# Cosmology

*Refer also to abstracts 20639, 21039, and 21104.*

**20807** INDUCED PAIR PRODUCTION AND OPACITY DUE TO BLACKBODY RADIATION. Bonometto, S. A. (Univ., Padua); Lucchin, F.; Marcolungo, P. Astron. Astrophys.; 31: No. 1, 41-46(Feb 1974).

A general scheme for studying the interaction between very high-energy particles and black-body radiation is presented. The case of electromagnetic interactions is studied in detail, and the fundamental role of the reaction $\gamma e \rightarrow 3e$ (induced pair production) as a limiting factor for the transparency of the Metagalaxy to very high energy photons and electrons is stressed. (auth)

**20808** NEW PRIMARY DYNAMO MECHANISM. Reinhardt, M.; Rosenblum, A. (Univ., Bonn). Astron. Astrophys.; 34: No. 1, 23-28(Aug 1974).

A new primary dynamo mechanism for the generation of cosmic magnetic fields in a plasma surrounding a rotating body is presented. The mechanism is based on the general relativistic dragging of inertial frames, which produces a centrifugal force field with nonvanishing curl thus driving the "battery" effect and giving rise to a toroidal magnetic field. A slow motion, weak field approximation is used. Several possible applications in astrophysics are discussed. The magnetic fields are estimated, generated by supermassive black holes in intergalactic space and in the nuclei of galaxies, supermassive stars, neutron stars, and black holes of stellar mass. However, in all the cases considered the effect is rather weak and the magnetic fields produced are probably of little astrophysical importance. (auth)

**20809** REPULSIVE PHENOMENA AND ENERGY EMISSION IN THE FIELD OF A NAKED SINGULARITY. de Felice, F. (Univ., Padua). Astron. Astrophys.; 34: No. 1, 15-19(Aug 1974).

Repulsive effects in the gravitational field of spinning naked singularity are analyzed and a physical interpretation is given. The repulsion is shown to be only apparent: it arises from a peculiar structure of space time. A particle on the axis of symmetry moves as if it were on the axis of a uniformly charged cylindrical cavity of finite dimensions. Whenever a particle loses energy, it can radiate away up to all of its rest mass energy. The frequency shift at infinity of the emitted radiation is also analyzed. (auth)

**20810** GRAVITY AND ITS ASTRONOMICAL IMPLICATIONS: AN ELEMENTARY GUIDE. Skinner, R. (Univ. of Saskatchewan, Saskatoon). J. Roy. Astron. Soc. Can.; 68: 173-201(Aug 1974).

The present work reviews with a minimum of mathematical illustration the basic principles in the physics of gravitation. Newton's laws of motion and gravitation are discussed and the relation between gravitational and inertial mass is examined. This leads to Einstein's principle of equivalence and his theory of general relativity. The concept of "pseudo forces" is examined, and the difference between gravity and other pseudo-forces is pointed out. Some basic ideas from the mathematics of curved spaces are explained, leading to the statement and brief explanation of Einstein's equation relating the geometry of a space–time structure with the gravitating sources within it. (IAA)

**20811** SIXTH TEXAS SYMPOSIUM ON RELATIVISTIC ASTROPHYSICS. Hegyi, D. J. (ed.). (Boston Univ.). Ann. N. Y. Acad. Sci.; 224: 1-364(14 Dec 1974).

The topics covered at the symposium include quasars, gravitational radiation, pulsars, black holes, detection of interstellar deuterium, solar oblateness, solar neutrinos, and physics at the origin of time. (WDM)

**20812** GRAVITATIONAL STOKES PARAMETERS. Anile, A.M. (Univ. Observatory, Oxford); Breuer, R. A. Astrophys. J.; 189: No. 1, 39-49(1 Apr 1974).

The electromagnetic and gravitational Stokes parameters are defined in the general theory of relativity. The general-relativistic equation of radiative transfer for polarized radiation is then derived in terms of the Stokes parameters, for both high-frequency electromagnetic and gravitational waves. The concept of Stokes parameters is generalized for the most general class of metric theories of gravity, where six (instead of two) independent states of polarization are present. (auth)

**20813** SIXTY YEARS OF EINSTEIN'S RELATIVITY THEORY. Gurevich, L.; Gliner, E. Veda Tech. SSSR; 2: No. 1, 29-35(Feb 1974). (In Czech).

Information is presented on the significance of the general relativity theory for the development of cosmology and the theory of the gravitational collapse. Also presented are the latest results of research carried out in these two spheres. (INIS)

**20814** AMPLIFICATION OF GRAVITATIONAL WAVES AND CREATION OF GRAVITONS IN THE ISOTROPIC UNIVERSES. Grishchuk, L. P. (Astronomical Inst., Moscow). Lett. Nuovo Cim.; 12: No. 2, 60-64(11 Jan 1975).

It is shown that weak classical gravitational waves in an isotropic nonstationary universe can amplify over the level permitted by the adiabatic law. This means a possibility of spontaneous graviton creation in the isotropic universe. In this respect gravitons drastically differ from neutrinos and photons which are not created in the isotropic cosmologies. (JFP)

**20815** MEASUREMENT OF SOLAR GRAVITATIONAL MICROWAVE DEFLECTION WITH THE WESTERBORK SYNTHESIS TELESCOPE. Weiler, K. W. (Univ. of Groningen, Netherlands); Ekers, R. D.; Raimond, E.; Wellington, K. J. Astron. Astrophys.; 30: No. 2, 241-248(Jan 1974).

A determination of the deflection of radiowaves at a frequency of 4995 MHz in the solar gravitational field was performed in October 1972 by measuring the relative positions of 3C 273 and 3C 279 during the occultation of 3C 279 by the Sun. Unique observing and analysis techniques reduced the atmospheric and instrumental instabilities to a level previously unobtainable in experiments of this type. At this accuracy, the effects of the bending in the solar corona were significant and required modeling. The measured gravitational deflection was then 0.96 ± 0.05 times the value predicted by general relativity. (auth)

## Planetary Phenomena

*Refer also to abstract 20931.*

**20816** CHEMISTRY OF THE MOON. Waenke, H. (Max-Planck-Institut fuer Chemie (Otto-Hahn-Institut), Mainz (F. R. Germany)). Fortschr. Chem. Forsch.; No. 44, 115-154(1974).

17 figs.; 13 tabs.; 132 refs.

The chemistry of lunar samples, europium anomaly, solar wind implantation, meteoritic components, formation of the lunar landscape, element correlations, condensation sequence of the planetary nebula, composition and structure of the Moon as well as origin of the Moon are dealt with in the form of a review. (GE)

**20817** OBSERVATIONS OF MOON–PLASMA INTERACTIONS BY ORBITAL AND SURFACE EXPERIMENTS. Schubert, G.; Lichtenstein, B. R. (Univ. of California, Los Angeles). Rev. Geophys. Space Phys.; 12: No. 4, 592-626(Nov 1974).

Extensive magnetic field observations together with crucial plasma measurements by the Explorer 35 lunar orbiter and Apollo surface and orbital experiments have established the basic nature of the Moon's interaction with the solar wind and interplanetary magnetic field. The effective absorption of the incident solar wind by the Moon creates a plasma void or cavity behind the Moon. The cavity-associated magnetic signature is characterized by an enhancement in magnetic field magnitude B within the cavity as compared with the mean level of B in the surrounding interplanetary plasma and dips or decreases in B near the cavity boundaries with the solar wind. The axis of the lunar wake is aberrated from the Moon–Sun line by the relative velocity of the solar wind with respect to the Moon, and the cross section of the wake is elliptical, reflecting the anistropic propagation of magnetoacoustic waves in the solar wind. (WDM)

**20818** CARBON CHEMISTRY OF THE APOLLO LUNAR SAMPLES. Eglinton, G.; Maxwell, J. R.; Pillinger, C. T. (Bristol Univ. (UK). Organic Geochemistry Unit). Fortschr. Chem. Forsch.; No. 44, 83-113(1974).

118 refs.; 10 figs.

Viable, dead and fossil microorganisms through solvent extractable carbon compounds, lunar surface processes, total carbon measurements, sources of carbon on the moon, mineralogical, pyrolytic and volatilization studies of the hydrolysis and acid dissolution, origins of hydrocarbons and carbides in the fines and breccias, carbon isotopes, carbon chemistry as an exposure and reworking parameter, analytical artifacts, compounds of N, P and S, and conclusions are dealt with. (GE)

# PHYSICS (ATMOSPHERIC)

## Auroral and Ionospheric Phenomena

**20819** RELATION BETWEEN THE SPORADIC E LAYER AND WIND IN THE IONOSPHERE. Spasov, Kh. V. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 27: No. 6, 783-786(1974). (In German).

Data on wind velocities and directions and on electron concentrations in the sporadic E layer are presented and discussed in order to gain some insights into the nature and extent of the dependence of sporadic E on drift components. It was found that sporadic E increases on days when a change in wind direction occurred, and that this increase in ionization occurs around the time of the change in wind direction. On calm days without change in wind direction, sporadic-E levels remain close to their mean values. These results support the view that intense winds and turbulence lead to additional ionization. (IAA)

**20820** PROPERTIES OF DIFFUSION-GRAVITATION PLASMA OSCILLATIONS IN THE IONOSPHERIC F REGION. Makeev, V. V.; Polyakov, V. M.; Rybin, V. V. (Irkutsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 17: No. 9, 1401-1404(1974). (In Russian).

Previous studies showing that the ionospheric reaction to external influences is shown by the formation and subsidence of layers with the characteristic profile of high-level distribution of the electron concentration led to the assumption that the diffusion-gravitational oscillations are an inherent property of the ionosphere. Equations expressing this assumption are derived and some of the properties and consequences of these equations are analyzed. (JSR)

**20821** STATIONARITY OF SCATTERING OF SHORT RADIO WAVES IN THE IONOSPHERE. Alimov, V. A. (Scientific-Research Radiophysical Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 17: No. 9, 1399-1401(1974). (In Russian).

The special statistical processing of experimental data on the stationarity of the scattering of short radio waves in the ionosphere using methods of mathematical statistics is discussed and applied to experimental data. The results showed the presence of stationarity in almost every 10-minute observation interval. (JSR)

**20822** DAILY VARIATIONS OF MAGNETIC-ION TWICE-REFRACTED COMPONENTS IN E LAYER. Pashova, T.; Serafimov, K. B. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 27: No. 6, 787-790(1974).

E-layer ionograms are presented and discussed in order to establish regularities in the appearance of a magnetic-ion split in the E layer during daytime. Daily changes in magnitude in cases when both magnetic-ionic components appear in the E layer are characterized by two maxima, one in the morning and one in the afternoon. Average duration of X component is about 1.5 to 2.5 hours. Analysis of monthly diagrams for an entire 14-year period reveals that the observed appearances and disappearances of the X component cannot be explained merely by the absorption effects of the lower-lying absorbing D region and of the intermediary D-E region. (IAA)

**20823** CHARACTERISTICS OF RADIO AURORA OCCURRENCES OBSERVED AT SYOWA STATION IN ANTARCTICA. Shiro, I.; Sakamoto, T. Denpa Kenkyusho Kiho; 19: 421-436 (1973). (In Japanese).

The occurrence characteristics of radio auroral echoes at 112 MHz observed at Syowa Station (Antarctica) during the period from April 1970 to February 1971 were analyzed. It was found that the diurnal variation in the frequency of the radio echo occurrence correlates well with the variation of the magnetic Q index. The occurrence frequency for the morning sector correlates comparatively well with the cosmic radio noise absorption recorded by a riometer, but no definite relation is found in the evening sector. In each hourly zone during the entire months of June and October, the ratio of the occurrence frequency of sporadic E accompanied by radar echoes to that of sporadic E alone is about 30% greater than in other months. The hourly averages of the critical frequency of sporadic E accompanied by radar echoes are generally greater than those for sporadic E alone. The product of the sporadic E critical frequency and the geomagnetic variation at a particular time gives a good indication of the appearance of auroral echoes. This implies that ionization irregularities capable of producing auroral echoes are influenced by the electric field in the sporadic E layer. (IAA)

**20824** LONGITUDINAL CHANGES IN THE DIURNAL VARIATION OF F-REGION IONIZATION IN WINTER. Berkeliev, M.; Dubrovskaya, E. K. (Inst. of Physics of Earth and Atmosphere, Ashkhabad, USSR). Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol.; No. 6, 53-58(1973). (In Russian).

Some of the characteristics of longitudinal changes in diurnal ionization variations for specified F-region altitudes during the winter season in a year of maximum solar activity are discussed. F-region ionization profile data from Washington, Moscow, and Ashkhabad stations are used. (IAA)

**20825** ARBEITSGEMEINSCHAFT IONIOSPHAERE, URSI, AND NACHRICHTENTECHNISCHE GESELLSCHAFT, GENERAL MEETING KLEINHEUBACH, WEST GERMANY, OCTOBER 8-13, 1973. Lectures. Kleinheubacher Ber.; 17: 1-589(1974). (In German and English).

Results of experiments investigating the electromagnetic properties of the ionosphere are presented, analyzed, and evaluated. Some of the topics discussed include: the instability of the thermosphere at midlatitudes during equinoxes, the dynamic behavior of the ionosphere in the Antarctic, low-energy electron measurements in the equatorial and polar ionosphere, models for the atmospheric surface duct over sea, analysis of whistlers from satellite data, and field strength fluctuations of a satellite telecommunications path. (IAA)

**20826** LABORATORY MEASUREMENTS OF IONOSPHERIC ION-MOLECULE REACTION RATES. Ferguson, E. E. (NOAA Environmental Research Labs., Boulder, CO). Rev. Geophys. Space Phys.; 12: No. 4, 703-713(Nov 1974).

The present status of laboratory measurements of ion-molecule reactions of ionospheric importance is reviewed. Rate constants for most of the normal terrestrial E and F region reactions have been reliably measured at 300°K. Recently, some data have become available on the energy dependences of the most important of these binary positive ion reactions. In the case of D region reactions a great deal of new data on both positive and negative ion reaction rate constants has appeared in recent years. Both binary reactions and three-body reactions are important in the D region, and important reactions still remain to be measured. (auth)

**20827** IONOSPHERIC PROPAGATION OF hf AND vhf RADIO WAVES ACROSS THE GEOMAGNETIC EQUATOR. Nielson, D. L. (Stanford Research Inst., Menlo Park, CA); Crochet, M. Rev. Geophys. Space Phys.; 12: No. 4, 688-702(Nov 1974).

Transequatorial propagation is influenced by many of the same equatorial F region events that have been identified by using other radio and optical sensors. The daytime equatorial ionosphere provides unusual long-range propagation conditions because of the peculiar latitudinal profile created by vertical drift over the magnetic equator. Radio signals reflected from this configuration are narrowly spread (coherent) yet have maximum frequencies that at times may reach 60 MHz. The inhomogeneities in the postsunset F region lead to a different, scatterlike propagation. Because of the wide range of scale sizes and plasma densities in the nighttime equatorial ionosphere, frequencies throughout the hf and vhf band are significantly distorted, and reflections can occur as high as 100 MHz. The irregularities responsible for these conditions follow the diurnal and seasonal trends of spread F only with certain qualifications. Horizontal and vertical drift of the scattering centers is evident from the use of both directional antennas and Doppler analysis. The reflection mechanisms are only partially accounted for, and the causes of the F region irregularities at all scale sizes are as yet unknown. (auth)

**20828** EQUATORIAL E REGION ELECTRIC FIELDS: LONGITUDINAL DIFFERENCES IN DIURNAL REVERSAL TIMES. Rastogi, R. G.; Chandra, H. (Physical Research Lab., Ahmedabad, India). Pramana; 3: No. 4, 236-242(Oct 1974).

The times of reversal of east-west electrostatic field in the ionosphere near the equator in the Indian zone were estimated from the measurements of ionospheric drift at Thumba. The reversal of electric field in the morning from westward to eastward is delayed with respect to the sunrise at 100 km by 1.5 hr during winter and by about 3 hr during summer months. The reversal in the evening from eastward to westward occurs around 2100 hrs, i.e., well after sunset during winter months and around 16 to 17 hrs, i.e., well before sunset during summer months. The electric field in the American zone is known to reverse 1 to 2 hr after the sunrise and sunset at 100 km; the duration of daytime eastward electric field varies with season between 12 and 16 hr. In the Indian zone, duration of the eastward field during the J months is only 8 hr. These longitudinal differences in the

reversal times of electrostatic field are suggested to be the cause of longitudinal differences in the equatorial ionosphere, viz., high incidence of blanketing sporadic E layer in the Indian zone and the longitudinal differences in the occurrence of spread F. (auth)

**20829** RELATION BETWEEN THE $E_s$ LAYER AND THE PERSEID METEOR SHOWER. Latipov, D. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 17: No. 5, 17-20(1974). (In Russian).

## Magnetospheric Phenomena

*Refer also to abstract 20746.*

**20830** MODES OF MAGNETOHYDRODYNAMIC WAVES IN THE MAGNETOSPHERE. Lanzerotti, L. J.; Fukunishi, H. (Bell Telephone Labs., Murray Hill, NJ). Rev. Geophys. Space Phys.; 12: No. 4, 724-729(Nov 1974).

Magnetohydrodynamic plasma waves (waves with frequencies less than the local ion gyrofrequency) constitute an important part of the wave frequency spectrum in the magnetosphere and in the solar wind. Such plasma waves also probably play an important role in astrophysical plasmas. The nature and modes of the plasma waves excited in the magnetosphere are of interest because they are generated and propagate in a plasma environment imbedded in a dipole magnetic field configuration. As such, analyses of the nature of these waves may prove useful in studies of some planetary and stellar plasma environments. Measurements made at conjugate points on the earth's surface and in the magnetosphere between spacecraft altitudes and the ground provide information on the nature of the modes of the magnetohydrodynamic waves excited in the magnetosphere. This paper reviews the available data on wave modes and concludes that near $L = 4$ (corresponding to geomagnetic latitudes ~60°) the mode for waves in the period range ~20 to ~200 s is predominantly odd mode. This may be a fundamental aspect of the physical process that couples the driving source to the resonant field line. For other geomagnetic and frequency ranges there is presently a disappointing dearth of experimental observations. (auth)

# PHYSICS (ATOMIC AND MOLECULAR)

## Beams and Their Reactions

**20831** INTENSE PULSES OF POLARIZED ELECTRONS PRODUCED BY FANO EFFECT. Drachenfels, W. V.; Koch, U. T.; Lepper, R. D.; Mueller, T. M.; Paul, W. (Bonn Univ. (F. R. Germany). Physikalisches Inst.). Z. Phys., 269: No. 4, 387-397(Sep 1974).

9 figs.; 1 tab.; 32 refs.

A pulsed polarized electron source using the Fano effect on cesium is described in detail. A frequency-doubled dye laser producing 2 mJ/pulse at 305 nm is used as the source of circularly polarized light. The light beam interacts with an array of 20 atomic beams. The atomic beam oven operates in a closed cycle—this mode increases running time by a factor of 30. Intensities of $3 \times 10^9$ $e^-/0.5$ μs with a polarization of 90% have been routinely obtained. (9 figures, 1 table) (auth)

**20832** MEASUREMENTS OF THE BACKSCATTERING COEFFICIENT AND OF THE SECONDARY ELECTRON YIELD ON POLYCRYSTALLINE MATERIALS AND OF THE ORIENTATION ANISOTROPY OF THE BACKSCATTERING COEFFICIENT IN THE ENERGY REGION BETWEEN 1 AND 10 keV. Drescher, H. (Muenster Univ. (F. R. Germany). Mathematisch-Naturwissenschaftliche Fakultaet). 29 Jun 1973. 42p. (In German). INIS.

24 figs.; 2 tabs.; 21 refs. Available from the library of Muenster Univ.

The backscattering coefficient for vertical incidence of primary electrons was measured on polycrystalline samples of Al, Cu, Ag and Au as well as on single crystalline Si in the energy region of 1 to 10 keV. It was thus confirmed that the backscattering coefficient for 1 keV electrons did not monotonicly rise with the atomic number Z as it does at higher energies, but that the value for Au (Z = 79) is below that of Cu (Z = 29). The secondary electron yield delta—measured like the backscattering coefficient for the vertical incidence of primary electrons—can be described by the expression delta approximately $E^{-0.8}$ for the examined elements between 4 and 10 keV. The absolute value of the orientation anisotropy of the backscattering coefficients strongly decreases for the elements Si and Ge between 10 and 100 keV as well as between 1 and 10 keV with increasing energy of the primary electrons. Contrary to this, in the case of Au, the anisotropy first increases, reaches its highest value at 6 keV and then falls again. The rise can be explained by the energy dependence of the backscattering coefficients of polycrystalline Au. The influence of higher Laue zones on the orientation anisotropy, which can be seen in channelling diagrams as microstructure, can be well described by a theory from Reimer. This theory also enables one, with the help of Monte-Carlo calculations, to calculate quantitatively, in a modified form, the dependence of the layer thickness on the orientation anisotropy satisfactorily. (24 figures, 2 tables) (GE)

**20833** OPTICAL RADIATION EMITTED AT HEAVY-ION BOMBARDMENT OF SOLIDS. Braun, M.; Emmoth, B.; Martinson, I. (Research Inst. for Physics, Stockholm). Phys. Scr.; 10: No. 3, 133-138(Sep 1974).

A number of solid targets were bombarded with 100 to 300 keV $Xe^+$ ions from a heavy-ion accelerator. Strong line spectra, showing transitions in neutral, singly- and doubly-ionized atoms were observed. Decay lengths were measured for a number of transitions and the results are compared to beam-foil data. (auth)

**20834** HIGHER ORDER EFFECTS IN THE EXCITATION AND IONIZATION OF ATOMS BY FAST HEAVY CHARGED PARTICLES. Hill, K. W. Sr. Chapel Hill, NC; Univ. of North Carolina (1974). 90p. University Microfilms Order No. 75-4827.

Thesis (Ph. D.).

Two topics relating to inelastic collisions of a heavy, fast particle of charge $Z_1$ e with an atom are treated: 1) contributions to the mean energy loss of the projectile and excitation probabilities of the atom due to polarization of the electronic orbitals, and 2) cross sections for multiple ionization of the atom. (Diss. Abstr. Int., B)

## Atomic and Molecular Properties

*Refer also to abstract 20362.*

**20835** (AD-783915) RESEARCH INVESTIGATION DIRECTED TOWARD EXTENDING THE USEFUL RANGE OF THE ELECTROMAGNETIC SPECTRUM. Progress Report No. 24, 1 July 1973-30 June 1974. Hartmann, S. R.; Happer, W. (Army Electronics Command, Fort Monmouth, N. J. (USA); National Aeronautics and Space Administration, Washington, D. C. (USA); National Science Foundation, Washington, D. C. (USA)). 30 Jun 1974. Contract DAAB07-69-C-0383. 160p. (CU-6-74-0383). NTIS $5.00.

Completed and proposed research in atomic and molecular physics conducted at the Columbia Radiation Laboratory from July 1972 to June 1973 is discussed. Central topics described include the atomic spectra and electronic structure of alkali metals and helium, molecular microwave spectroscopy, the resonance physics of photon echoes in some solid state systems (including Raman echoes, superradiance, and two photon absorption), and liquid helium superfluidity. (auth)

**20836** DETERMINATION OF THE GROUND STATE OF Th III. Litzen, U. (Univ. of Lund, Sweden). Phys. Scr.; 10: No. 1-2, 103-104(Jul 1974).

The Th III spectrum was observed in the region 10,000 to 30,000 Å, and ten lines were identified as transitions between the two previously unconnected parts of the term system. This makes $5f6d^3H_4$ the ground level of Th III. The first excited level, $6d^2\ ^3F_2$, is situated only 63.2 $cm^{-1}$ above the ground level. (auth)

**20837** ELECTRONIC RECOMBINATION OF $He_2^+$. Boulmer, J.; Stevefelt, J.; Delpech, J. F. (Groupe d'Electronique dans les Gaz, Institut d'Electronique Fondamentale, 220 Faculté des Sciences, 91405—Orsay, France). Phys. Rev. Lett. 33: No. 20, 1248-1249 (11 Nov 1974).

The measured molecular spectrum of a helium afterglow plasma does not fit with available recombination theories. Highly excited states are in thermal equilibrium at a substantially different temperature than that of free electrons. (auth)

**20838** VARIATIONAL ESTIMATES OF $\langle \Sigma_i r_i^q \rangle$ FOR q = −1, 1, AND 2 FOR ATOMS WITH Z FROM 2 TO 18. Mueller, R. O., Rau, A. R. P.; Spruch, L. (New York Univ.). Phys. Rev., A; 10: No. 5, 1511-1518(Nov 1974).

The utility of variational principles for the estimation of the expectation values of certain operators, so far established only for helium, was tested for atoms with Z from 2 through 18 for the operators $\hat{r}^q \equiv \Sigma_i r_i^q$ for q = −1, 1, 2 using simple atomic wave functions. The trial wave function $\psi_t$ is taken to be a Hartree product of hydrogenic orbitals with different effective charges fixed through phenomenological approaches such as Slater's empirical screening rules. This form for $\psi_t$ is particularly useful for these exploratory calculations since all steps in the variational method can actually be carried out analytically. Results for $\langle \hat{r}^{-1} \rangle$ and $\langle \hat{r} \rangle$ are obtained through neon, while for the more interesting case of $\langle \hat{r}^2 \rangle$ they are extended up through argon. The results for $\langle \hat{r}^2 \rangle$ are generally the least accurate and are especially sensitive to the choice of effective charges, since they depend almost entirely on the outermost electrons whereas the $\psi_t$ used represents an average description of the atom. The variational estimates of $\langle \hat{r}^2 \rangle$ represent a substantial improvement over the zeroth-order estimates and agree to within about 3 to 10% with the Hartree-Fock results. The simplicity and relative accuracy of these calculations generally support the utility of the variational principle and suggest future calculations with a better $\psi_t$ as a starting point. (auth)

**20839** RECENT PROGRESS IN STUDIES OF ATOMIC SPECTRA AND TRANSITION PROBABILITIES BY BEAM-FOIL SPECTROSCOPY. Martinson, I. (Research Institute for Physics, Stockholm). Phys. Scr.; 9: No. 5, 281-296(May 1974).

From 5th annual conference of the European Group for Atomic Spectroscopy; Lund, Sweden (10 Jul 1973).

Positive ions, accelerated to energies ranging from approximately 20 keV to more than 400 MeV, have for about ten years been successfully used in atomic physics research. This method, beam-foil spectroscopy (BFS) has gradually developed into a standard technique for atomic structure investigations. The problems that have been tackled so far can be roughly divided into energy levels in atoms and ions, level lifetimes and atomic transition probabilities, Stark- and Zeeman-effects, including g-value measurements, fine- and hyperfine-separations of atomic energy levels, Lamb shifts in one- and two-electron atoms, and atomic collision mechanisms. After a short survey of experimental aspects recent investigations of atomic spectra and transition probabilities by the beam-foil method are summarized. (auth)

**20840** RECENT PROGRESS ON THE INTERPRETATION OF THE $4f_N(5d + 6s)$ CONFIGURATIONS IN THE LANTHANIDES. I. Wyart, J. F.; Blaise, J.; Camus, P. (Centre National de la Recherche Scientifique, Orsay, France). Phys. Scr.; 9: No. 6, 322-324(Jun 1974). (In French).

There are a number of regularities evident when one compares the first four levels of the $4f^N5d$ (in spectra II) and $4f^N5d6s^2$ (in spectra I) for $8 \leq N \leq 13$. By this empirical method the energies were found for the low lying levels of $f^{11}d$ for HoII and one energy level for TbII. (auth)

**20841** BEAM-FOIL SPECTROSCOPY OF HIGHLY IONIZED ARGON. Buchet, J. P.; Buchet-Poulizac, M. C.; Denis, A.; Desesquelles, J.; Do Cao, G. (Univ., Lyon). Phys. Scr.; 9: No. 4, 221-225(Apr 1974).

The spectra of argon are investigated between 150 Å and 5500 Å using the beam–foil technique at 1.15 MeV/nucleon. More than thirty observed lines were identified as hydrogenic transitions in Ar X-XV. In the uv range, most lines are due to 3-3 and $2s^22p^n - 2s2p^{n+1}$ transitions. (auth)

**20842** LINE IDENTIFICATIONS IN THE BEAM-FOIL SPECTRUM OF BORON. Berry, H. G. (Chicago Univ.). Phys. Scr.; 9: No. 4, 217-220(Apr 1974).

Many new lines between 2000 and 5500 Å from displaced terms in the B II spectrum are observed using the beam-foil technique. Possible transitions in the doubly-excited quartet system of B III are compared with previous observations in Be II. Other transitions in B II, B III, and B IV are also identified. (auth)

**20843** LEVEL CROSSING INVESTIGATION OF THE HYPERFINE STRUCTURE OF $^{209}Bi$ IN THE $6p^2(^3P)6d^2D_{\frac{5}{2}}$ AND $6p^2(^3P_1)7s^4P_{\frac{5}{2}}$ LEVELS OF THE Bi I SPECTRUM. Holmgren, L.; Svanberg, S. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 9: No. 4, 211-212(Apr 1974).

The level crossing method was used to measure the hyperfine structure of $Bi^{209}$ in the $6p^2(^3P_0)6d^2D_{\frac{5}{2}}$ and $6p^2(^3P_1)7s^4P_{\frac{5}{2}}$ levels of the Bi I spectrum. For the magnetic dipole and the electric quadrupole interaction constants a and b the following values were obtained: $|a(6p^2(^3P_0)6d^2D_{\frac{5}{2}})| = 128.0(0.6)$ $(g_J/-0.79)$ MHz; $|b(6p^2(^3P_0)6d^2D_{\frac{5}{2}})| = 58(4)$ $(g_J/-0.79)$ MHz; $|a(6p^2(^3P_1)7s^4P_{\frac{5}{2}})| = 95(4)$ MHz. (auth)

**20844** FUNDAMENTAL AND FIRST OVERTONE BANDS IN THE RAMAN SPECTRA OF SOLID HYDROGEN AND DEUTERIUM. Prior, W. R. Toronto; Univ. of Toronto (1971). 173p.

Thesis.

The Raman spectra of solid hydrogen and deuterium were studied using an argon laser for excitation. New information about the vibrational and rotational portions of the spectra has been obtained, and the first overtone and several combination transitions were observed for the first time. The dependence of these lines on the concentration of the J = 1 species (1 to 99% of o-$H_2$, 5 to 95% of p-$D_2$) and temperature (1.3 and 4.3°K) was examined. Effects due to quadrupolar coupling between J = 1 molecules were observed. At very low orthohydrogen concentration, the $Q_1$ (1) transition has two components, the relative intensities of which vary with concentration and temperature. One of these is shown to be predominantly due to transitions in single ortho molecules, the other to pairs of neighbouring ortho molecules, the energy of the latter being lowered due to the greater quadrupolar interaction in the excited state. (CA)

**20845** GROUND STATE ENERGIES OF FIRST-ROW ATOMS AND IONS. Callan, E. J. (Aerospace Research Labs., Wright-Patterson AFB, OH). Int. J. Quant. Chem., Symp.; No. 8, 29-36 (1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Truncation of the interelectron Coulomb potential at a minimum distance related to the energy has resulted in obtaining simple analytic forms for ground and excited state two-electron systems yielding good agreement for energies in comparison with other calculations. Extension of these methods using hydrogenic type wave functions was accomplished for the Li–Ne isoelectron sequences. Ground state atom energies agree with "exact" non-relativistic energies to within 0.1%, ranging from differences of –0.00030 a.u. for Li and 0.00057 a.u. for Be up to a maximum difference of 0.05562 a.u. for F and 0.01339 a.u. for Ne. Tabulation of the energies of the ions for each sequence is given up to Z = 10. For Li to C the calculated ionization potentials agree with experiment to within 0.25 eV, but become progressively worse as the number of 2p electrons increases. For Ne the calculated ionization potential is only 15.835 eV rather than the experimental value of 21.55 eV. For ion energies the maximum differences from best other calculations are 0.25 a.u. for $Ne^+$, decreasing to 0.02 a.u. or less for the 3- and 4-electron sequences, and tend to decrease with an increase in the degree of ionization. (auth)

**20846** RELATIVISTIC CRYSTAL-FIELD RADIAL INTEGRALS FOR RARE-EARTH IONS. Rosen, A.; Waber, J. T. (Northwestern Univ., Evanston, IL). Int. J. Quant. Chem., Symp.; No. 8, 127-136(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

The purpose is to indicate the importance of using relativistic self-consistent-field wave functions for the calculation of crystal-field radial integrals. In relativistic calculations the wave functions corresponding to $j = l \pm \frac{1}{2}$ are different and give different radial integrals. In order to facilitate comparison with nonrelativistic results it is convenient to apply the effective-operator technique in crystal-field calculations as has been done for a long time in hyperfine-structure analysis. General formulas are given for the relativistic effective-field Hamiltonian with the corresponding radial integrals. Theoretical values of radial integrals calculated with both relativistic Hartree-Fock and Hartree-Fock-Slater type wave funtions are given for $Gd^3$ and $Er^{3+}$. (auth)

**20847** EXTENDED HUECKEL $\beta$ PARAMETERS APPLIED TO DIATOMIC MOLECULES. Engelke, S. Z. (Los Alamos Scientific Lab., NM); Beckel, C. L. Int. J. Quant. Chem., Symp.; No. 8, 209-217(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Atom–atom separations predicted by extended Hückel theory using four $\beta$ parameter approximations are compared for 15 diatomic molecules. Equilibrium separations $R_e$ determined from a new proposed formula for the $\beta$ parameter are compared with $R_e$ resulting from the Mulliken–Wolfsberg–Helmholtz, Cusachs, and Jug $\beta$ formulas. Results show that the new $\beta$ is best in its prediction of $R_e$. The new formula has the required property of yielding rotationally invariant results. (auth)

**20848** DESCRIPTION OF THE DISPERSION TERM BETWEEN TWO MOLECULES AND TWO ATOMS FROM AN AB INITIO PERTURBATIVE PROCEDURE: $H_2 + H_2$ and Ne + Ne. Kochanski, E. (Louis Pasteur Univ., Strasbourg). Int. J. Quant. Chem., Symp.; No. 8, 219-227(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

From the examples of two hydrogen molecules and two neon atoms an attempt was made to show some of the characteristics of the dispersion term in an ab initio perturbation procedure; for example, the importance of different partitionings of the molecular Hamiltonian, the need for diffuse polarization functions, the rather good agreement between the Hartree–Fock dispersion term and the semiempirical results using the multipole expansion, and the importance of certain molecular orbitals (auth)

**20849** SINGLE-ELECTRON AND TOTAL ENERGIES FOR SOME PAIRS OF NOBLE GAS ATOMS. Bellum, J. C.; Micha, D. A. (Univ. of Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 8, 229-240(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

The MSX$\alpha$ method was used to investigate the electronic structure of the atom pairs He–He, He–Ar, and Ar–Ar. Results are presented for ground state and excited state configurations over a wide range of R values. The computed interactions exhibit Born–Mayer repulsion, and the calculations demonstrate how the X$\alpha$ orbital energies can be used to predict crossings between interaction potentials. An analysis is presented of the usefulness of the X$\alpha$ theory for the understanding of collision phenomena. (auth)

**20850** LONG- AND INTERMEDIATE-RANGE INTERACTION BETWEEN TWO GROUND STATE HYDROGEN ATOMS. Kolos, W. (Univ. of Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 8, 241-252(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Perturbation theory in the polarization approximation was employed, without using the multipole expansion for the interaction Hamiltonian, to calculate the second- and third-order interaction energies of two ground state hydrogen atoms for internuclear separations R = 4(2)12a.u. Using recently computed variational energies for H–H and H–$\bar{H}$, the values of higher order corrections to the interaction energy were estimated. The accuracy of several approximations commonly used in calculations of intermolecular interaction energies was tested. (auth)

**20851** DISPERSION COEFFICIENTS AND FREQUENCY-DEPENDENT POLARIZABILITIES. Ahlberg, R. (Uppsala Univ.). Int. J. Quant. Chem., Symp.; No. 8, 363-377(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Extensions of previous methods for obtaining two- and three-body dispersion coefficients are presented. Many-dimensional arrays in inner projections are utilized. The required matrix elements are expressed in terms of atomic frequency (Cauchy) moments. Approximate dynamic polarizabilities are derived using generalized inner projections, and a number of theorems for definite operators are extended to more general cases. Numerical results for both two- and three-body dispersion coefficients are reported. (auth)

**20852** EXCITATION HAMILTONIAN OF ELECTRONIC SYSTEMS USING OAO. Collins, T. C. (Aerospace Research Labs., Wright-Patterson AFB, OH); Kunz, A. B. Int. J. Quant. Chem., Symp.; No. 8, 437-445(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

An excitation Hamiltonian is formulated by adding an operator, $\hat{O}\hat{A}\hat{O}$, to the Fock operator whose eigenvalue differences represent excitations of electronic systems. $\hat{O}$ is an operator which projects onto the virtual space of the Fock operator and $\hat{A}$ is chosen so that one has a Koopmans' theorem and a variational principle for these states. The formalism is then used to calculate excitation energies of atomic He, Li, and Be. (auth)

**20853** MEAN M-SUBSHELL FLUORESCENCE YIELDS AT Z = 88, 90, 92, AND 94. Baker, K. R.; Tolea, F.; Fink, R. W. (Georgia Inst. of Tech., Atlanta (USA). School of Chemistry); Pinajian, J. J. (Oak Ridge National Lab., Tenn. (USA). Isotopes Development Center). Z. Phys.; 270: No. 1, 1-7(Sep 1974).

4 figs.; 3 tabs.; 21 refs.

M x-ray–L x-ray coincidence measurements with high-resolution, cooled Si(Li) x-ray detectors were made on transitions following the alpha decays of $^{228}$Th, $^{232}$U, $^{238}$Pu, and $^{244}$Cm, in order to determine the mean M-subshell fluorescence yields. Furthermore, the nonradiative M-shell transition probability and the radiative $L_1-L_3$ transition probability were measured for Z = 88, 90, 82 and 94 and compared with calculations of McGuire and of Scofield. (GE)

**20854** ABSORPTION BY A HYDROGENIC SERIES OF OVERLAPPING LORENTZIAN LINES. Brown, R. T. (Los Alamos Scientific Lab., NM). J. Quant. Spectrosc. Radiative Transfer; 14: No. 12, 1351-1354(Dec 1974).

An expression suitable for rapid numerical calculation is derived for the evaluation of the infinite sum describing the absorption due to a hydrogenic series of Lorentzian lines. An example is shown, applied to the n = 1 series of singly ionized helium. (auth)

**20855** INVESTIGATIONS OF THE HYPERFINE STRUCTURE OF Dy I BY MEANS OF THE ATOMIC BEAM RESONANCE METHOD. Ferch, J. (Bonn Univ. (F. R. Germany). Mathematisch-Naturwissenschaftliche Fafultaet). 20 Jun 1972. 160p. (In German). INIS. Available from the library of Bonn Univ.

After an extensive reconstruction of an atomic beam resonance apparatus, the hyperfine structure of Dy I was investigated by the atomic beam resonance method. By the induction of suitable high-frequency transitions the following constants could be determined: A, B, C, D, $g_J$, $g_I$ for $^{161}$Dy; for $^{163}$Dy, $^5I_8$; for $^{162}$Dy, $^5I_8$ and the constant $g_J$; and for $^{164}$Dy, $^5I_8$, the constants $g_J$ and $g_I$. Second-order perturbation theory contributions are considered in these results. A sign determination of the A factors with a special experimental arrangement gave a negative sign for A($^{161}$Dy) and a positive one for A($^{163}$Dy). The B factors of both isotopes must accordingly be positive. From the A and $g_I$ factors one obtains for the radical parameter $\langle r^{-3}\rangle_{4f}$ of the magnetic dipole interaction, the value $\langle r^{-3}\rangle_{4f} = 8.59(4)\ a_0^{-3}$. The nuclear moments for $^{161}$Dy and for $^{163}$Dy were determined. When considering the diamagnetic shielding and the Sternheimer effect, one obtains: $^{161}$Dy $\mu_I$' = −0.4792(50) $\mu_k$, $Q_s$ = 2.44(17) b, $^{163}$Dy $\mu_I$' = 0.6707(35) $\mu_k$, $Q_s$ = 2.57 (17 b. (GE)

**20856** PHOTOIONIZATION OF $H_2$ AND He IN THE keV ENERGY RANGE. Wang, T. C. Eugene, OR; Univ. of Oregon (1974). 103p. University Microfilms Order No. 75-3929.

Thesis (Ph. D.)

The photoionization cross sections of molecular hydrogen and of helium in the keV energy range were measured. The cross sections were determined by counting photoelectrons released by monochromitized x rays traversing highly purified gas. This new method is more reliable for very small cross sections than the absorption-cell technique and permits a direct measurement of the photoionization cross section alone, even when competing processes dominate. The photoionization cross sections (per atom) of molecular hydrogen, both at 5.4 and at 8.4 keV, are found to be (44 ± 8)% higher than the theoretical cross sections for atomic hydrogen. This is the first molecular bonding effect on photoionization ever found to exist well above threshold. The photoionization cross sections of helium, measured by the same method, are in good agreement with the results of recent theoretical work. (Diss. Abstr. Int., B)

**20857** SELF-ENERGY RADIATIVE CORRECTIONS IN HYDROGEN-LIKE SYSTEMS. Mohr, P. J. (Lawrence Berkeley Lab., CA). Ann. Phys. (N. Y.); 88: No. 1, 26-51(Nov 1974).

The one-photon self-energy radiative level shift of an electron in a Coulomb field is examined. An expression for the level shift which is suitable for direct numerical evaluation, for Z in the range 10 to 110, is obtained. It is based on the known Coulomb radial Green's functions and not on a power series expansion in $Z\alpha$. (auth)

**20858** NUMERICAL EVALUATION OF THE $1S_{\frac{1}{2}}$-STATE RADIATIVE LEVEL SHIFT. Mohr, P. J. (Lawrence Berkeley Lab., CA). Ann. Phys. (N. Y.); 88: No. 1, 52-87(Nov 1974).

The one-photon self-energy radiative level shift for an electron in a Coulomb potential is evaluated numerically for the $1S_{\frac{1}{2}}$ state. The evaluation is done for values of the nuclear charge Z = 10, 20, ..., 110. The errors in the values obtained are estimated to be less than 0.1%. The results are compared with the results of previous calculations. The evaluation is based on the expressions given previously. (auth)

**20859** AN EXPERIMENTAL INVESTIGATION OF THE ONSET OF THE $L_2-L_3M_4$ AND $L_2-L_3M_5$ COSTER–KRONIG TRANSITIONS FOR Z > 90. Baker, K. R.; Tolea, F.; Fink, R. W. (Georgia Inst. of Tech., Atlanta (USA). School of Chemistry); Pinajian, J. J. (Oak Ridge National Lab., Tenn. (USA). Isotopes Development Center). Z. Phys.; 270: No. 1, 9-15(Sep 1974).

5 figs.; 3 tabs.; 15 refs.

L–M coincidence measurements were made on X-rays from the radioactive decays of $^{244}$Cm, $^{238}$Pu, and $^{232}$U. The observation of M X-rays in coincidence with the $L_3N_{4,5}$ transition indicates that the onset of the $L_2-L_3M_5$ Coster–Kronig transition takes place at Z = 91 or 92. The measured ratio of the M X-ray counting rates, coincident with the $L_3N_{4,5}$ and $L_2M_4$ transitions, establishes that both the $L_2-L_3M_4$ and the $L_2-L_3M_5$ transitions are energetically possible for Z >= 94, but the results do not rule out the possibility that these transitions begin as low as Z = 92. The measurement of L–M X-ray coincidences, together with relative Coster–Kronig electron intensities from theory or experiment, provides a new way to measure the total $L_2-L_3$ Coster–Kronig transition probability, $f_{23}$, at high Z for radioactive sources where the primary vacancies are created primarily in the $L_2$ and $L_3$ subshells. (auth)

## Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

*Refer also to abstracts 21316 and 21323.*

**20860** COMMENTS ON PROPOSED EXPLANATIONS FOR THE MUONIC–ATOM X–RAY DISCREPANCY. Adler, S.L.; Dashen, R.F. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510 and The Institute for Advanced Study, Princeton, New Jersey 08540); Treiman, S.B. Phys. Rev. D 10: No. 11, 3728-3735 (1 Dec 1974).

Two proposed explanations for the apparent muonic atom x-ray discrepancy are the possible existence of nonperturbative vacuum polarization modifications and the possible existence of a weakly coupled light scalar boson. We show that a nonperturbative decrease in the vacuum polarization spectral function implies a reduction in the vertex for a timelike photon to couple to an electron–positron pair. This would lower by a few percent the rate for $\pi^0$ Dalitz decay and suggests observable effects in the colliding beam reactions $e^+e^- \to e^-e^+$, $e^+e^- \to \mu^+\mu^-$. Turning to the scalar–boson hypothesis, we use neutron–electron and electron–deuteron scattering data to show that a scalar particle with mass lighter than about 0.6 MeV cannot be invoked to explain the muonic discrepancy. We conclude by discussing the useful role which isotope effects and pionic–atom experiments might play in determining the phenomenological structure of the extra potential implied by the discrepancy. (auth)

**20861** HYPERFINE EFFECTS IN PARITY–VIOLATING MUONIC–ATOM DECAYS. Feinberg, G.; Chen, M.Y. (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 10: No. 11, 3789-3795 (1 Dec 1974).

The effect of hyperfine interactions on the parity–violating correlations in the decay $2S_{1/2} \to 1S_{1/2} + 1\gamma$ in muonic atoms is considered. It is shown that hyperfine effects make the photon

momentum correlations with the initial or final muon polarization unequal to each other, and unequal to the photon circular polarization. Also, there is an additional parity–violating term in the muon–proton Hamiltonian, proportional to the nuclear spin, which contributes differently to the three spin correlations. Therefore, if measurements of two of these correlations are possible in light atoms, both parity–violating coupling constants can be determined. (auth)

**20862** K-NUCLEUS OPTICAL POTENTIAL FOR KAONIC ATOMS. Alberg, M. A. Seattle; Univ. of Washington (1974). 145p. University Microfilms Order No. 74-29,364.
Thesis (Ph. D.).

A nonlocal, energy-dependent, self-consistent kaon-nucleus optical potential is derived for kaonic atoms. Energy level shifts and widths are calculated for several light nuclei, and the results are compared with experiment. The sinsitivity of the results to changes in parameters of the nuclear matter distribution is studied. Nonlocality and off-energy-shell effects are examined. The optical potential is derived by means of a Brueckner-type many-body theory with the independent pair approximation for the kaon and the nucleon. The two-body interaction on which the optical potential depends is represented by separable potentials of the Yamaguchi form. Coupled channels ($\bar{K}N$ and $\Sigma\pi$) are used for the I = 0 states, which are dominated by the $Y_1^*$ resonance, and only a single channel ($\bar{K}N$) is used for the I = 1 state. Calculations are carried out in three levels of approximation of the nonlocal, energy-dependent optical potential. In no approximation is the potential found to be proportional to the nuclear density. Indeed, the real part of the potential changes sign in the nuclear surface. Sensitivity of the results to variations in the nuclear matter distribution is investigated and found to be on the order of experimental error. Nonlocality and off-energy-shell effects are estimated to be at least as large as this error, so that these effects must be included if one wishes to extract information about the nuclear surface from the existing experimental data. The use of correct nucleon wave functions and binding energies is similarly found to be essential in the calculation. (Diss. Abstr. Int., B)

**20863** RELATION BETWEEN THE MECHANISM OF $\pi^-$ MESON HYDROGEN CAPTURE AND RADIATION CHEMICAL REACTIONS. Gol'danskii, V. I.; Zatsepina, N. N.; Tupitsyn, I. F.; Kholodiv, N. I. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 216: No. 6, 1250-1253(21 Jun 1974). (In Russian).

The behavior of negative mesons at the level of molecular or atomic trapping can be similar to the behavior of fast electrons of nucleophile reagents. Therefore one would expect an analogy between the processes of negative meson trapping and elementary acts, characteristic of radiation chemistry, of interactions induced by electron collisions and of nucleophile processes with participation of dry or solvated electrons. The existence of such an analogy is shown on a series of examples. An attempt is also made to use concepts of radiation chemistry to interpret some structural and isotopic effect occurring during the capture of $\pi^-$ mesons by hydrogen atoms in different classes of organic and inorganic compounds. (JSR)

# Collision Phenomena

*Refer also to abstracts 20889 and 21333.*

**20864** (AD-783914) ROTATIONAL EXCITATION OF $N_2^+$ $B^2\Sigma_u^+$ PRODUCED IN COLLISIONS OF ATOMIC HYDROGEN WITH $N_2$. Birely, J. H. (Aerospace Corp., El Segundo, Calif. (USA)). 15 Jul 1974. Contract F04701-74-C-0075. 8p. (SAMSO-TR-74-161). NTIS $3.00.

The rotational excitation of $N_2^+$ $B^2\Sigma_u^+$ formed in collisions of 20 keV H with $N_2$ is shown to be adequately characterized by a Boltzmann distribution having a rotational temperature equal to the kinetic temperature of the nitrogen target. (auth)

**20865** (AD-783919) MATERIALS RESEARCH PROGRAM IN HIGH ENERGY GAS PHASE SYSTEMS. Final Scientific Report, 1 June 1973–31 May 1974. Fritzsche, H. (Chicago Univ., Ill. (USA); Army Research Office, Durham, N. C. (USA); USAEC, Washington, D. C.). Aug 1974. 39p. NTIS $3.25.

Results of 11 faculty members of the Materials Research Laboratory of the University of Chicago are summarized in abstract form. The theoretical and experimental research effort concentrated on the understanding of electronically excited atoms and molecules and on the detailed dynamics of collision processes between atoms and/or molecules. New results are presented on photochemical reactions, intramolecular and intermolecular energy transfer, intermolecular potentials, and the energy distribution in exothermic chemical reactions. New experimental methods employed include beam-foil spectroscopy, microwave-optical double resonance, crossed molecular beams with angular and velocity distribution analysis of reaction products and analysis of their rotational and vibrational states. A list of 86 scientific papers on this research is included. (auth)

**20866** (COO-3235-39) COMPUTATIONAL STUDY OF CHANNEL COUPLING ARRAYS: LOW ENERGY $e^-$–H SCATTERING PARAMETERS IN THE 1S APPROXIMATION. Kouri, D. J.; Levin, F. S.; Craigie, M.; Secrest, D. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 28p. Dep. NTIS $4.50.

Low energy electron-hydrogen scattering parameters were calculated using the new set of coupled equations for the transition operators for different arrangement channels derived recently. A key feature of this approach to multi-channel scattering is the use of the channel coupling array, W, whose elements link the various channels together and thus determine which arrangements are explicitly coupled in the equations. The dependence of the low energy scattering parameters on the elements $W_{ij}$ is studied numerically within an approximation retaining only the n = 1, hydrogen ground state in the expansion of the channel Green's operator. Because of the channel coupling, this is not the same approximation as the familiar static or static exchange approximation of more conventional calculations. The best results for singlet and triplet parameters taken together occur for the channel permuting array values $W_{11} = W_{22} = 0$, $W_{21} = W_{12} = 1$; these are the values that guarantee a connected integral equation for the matrix of transition operators. In particular, singlet and triplet scattering length values (in a.u.) of 6.230 and 2.077 are found, which compare well with the variational results of Schwartz, 5.96 and 1.77. (auth)

**20867** (COO-3235-43) CHANNEL COUPLING ARRAYS AND THE REDUCTION METHOD IN MANY-BODY SCATTERING. Hahn, Y.; Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 15p. Dep. NTIS $4.00.

A differential equation formulation of the multi-channel, coupled equations of Kouri and Levin describing rearrangement scattering is given. The different channels are linked together in these equations through the presence of the channel coupling array W. It is shown that the earlier results of Hahn, derived using the reduction method, follow directly from the multi-channel coupled equations by making specific choices of the array W. These particular W's guarantee that the iterated kernels of the coupled equations are connected in those channels which are explicitly considered, so that standard numerical techniques can be applied to their solution. (auth)

**20868** (COO-3235-50) RESOLUTION OF SOME ORTHOGONALITY AND EXPANSION-SET PROBLEMS IN MANY-BODY SCATTERING THEORY. Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 12p. Dep. NTIS $4.00.

A modification to the coupled channel equations for many-body scattering is introduced, based on the evaluation of the discontinuity equation for the matrix of transition operators. The resulting (modified) equations are shown to be in a form which resolves some problems associated with continuum states in an analysis of rearrangement collisions using the eigenstate expansion method. (auth)

**20869** (FUPH-R-108) ELECTRON PHOTON ANGULAR CORRELATIONS IN THE ELECTRON IMPACT EXCITATION OF ARGON. Arriola, H.; Teubner, P. J. O.; Ugbabe, A.; Weigold, E. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Oct 1974. 11p. Dep. NTIS (US Sales Only) $4.00.

A coincidence technique was used to measure angular correlations between electrons which have excited the first excited state of argon and the photons arising from the decay of this state to the ground state. The ratio of the differential cross sections for the excitation of the degenerate substates and the relative phases were deduced from the correlations for incident electron energies of 80 and 113 eV and electron scattering angles of 8.5°. The angular correlations show poor agreement with those predicted by the Born approximation. (auth)

**20870** (LBL-3154) ION MOLECULE REACTIONS: CORRELATION TIME-OF-FLIGHT ION SPECTROSCOPY AND THE $CO_2^+$–$H_2$ SYSTEM. Schubart, P. J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1974. Contract W-7405-eng-48. 278p. Dep. NTIS $17.00.
Thesis.

A time-of-flight analysis system for measurement of velocity distributions of the ionic products of gas phase ion-molecule reactions was developed. The system employed pseudorandom binary noise for ion source modulation, coupled with detector cross correlation for extraction of velocity distribution spectra. Cross

correlation was accomplished by direct memory access storage of coded correlation information by a PDP 8/f minicomputer with subsequent application of a decoding algorithm for transformation of accumulated data. Maximal length shift register sequences were utilized for ion source modulation. The modulation code sequence was transduced for beam gating by an electrostatic deflection beam chopper. Storage of the modulation sequence for later cross correlation was accomplished with a variable length digital delay line. The hardware options of the computer correlation interface were controlled by a software implemented, keyboard controlled system monitor computer program. The time-of-flight system was applied to an existing ion beam apparatus for measurement of $N^+$, $N_2^+$, and $Kr^+$ ion velocity distributions. Measured $N_2^+$ distributions agreed well with retarding potential energy analysis measurements. The $Kr^+$ velocity distribution clearly resolved mass peaks due to three naturally occurring isotopes. In a separate series of experiments, intensity distribution maps of the products of the $CO_2^+ + H_2$ reaction were measured over an initial $CO_2^+$ laboratory energy range of 25 to 250 eV. At low energies there was strong evidence of long lived intermediate complex formation. With increasing relative energy there occurred a transition to a direct spectator stripping mechanism. Intensity distributions for six ionic products were measured at various relative energies. $DCO_2^+$ product distributions reflected a large amount of direct interaction formation even at low energies, although the broad distribution at low energy suggested an intensity contribution from complex formation. With increasing energy $DCO_2^+$ distributions continually reflected a larger proportion of formation by direct stripping interaction up to 10 eV relative energy. Above 10 eV significant intensity loss due to product dissociation was noted accompanied by forward movement of the product intensity peak indicating product stabilization by forward recoil. The $DCO^+$ product distributions displayed the symmetric behavior of complex formation at low energy. Increasing energy led to distribution asymmetry and forward peak movement. High energy distribution peaks and intensity levels were explained in terms of two stripping mechanisms. Nonreactive $CO_2^+$ distributions showed broad inelastic intensity even at low relative energies, in contrast with $CO_2^+$ scattered nonreactively by He. This was further evidence for low energy complex formation and showed significant translation to vibration energy transfer. The $CO^+$ and $O^+$ product distributions showed a collisional dissociation mechanism. The $OD^+$ distributions showed forward scattering and low intensity. No $D_2O^+$ product was noted at any energy studied. The $CO_2^+ + H_2$ product distributions were analyzed in terms of molecular orbital correlation diagrams. There was reasonable qualitative agreement between theoretical expectations and experimental results. (auth)

**20871** (UCRL-Trans-10815) LUMINESCENCE OF ARGON INDUCED BY ALPHA PARTICLES. Henck, R.; Voltz, R. 1970. Translation of pp 151-168 of Comptes Rendus du 92e Congres National des Societes Savantes. Volume II. (CONF-670342-1). 28p. Dep. NTIS $4.50.

From 92nd national congress of the learned societies; Strasbourg, France (31 Mar 1967).

Ultraviolet and visible emission from argon excited by alpha particles is discussed. Using methods resembling the single photoelectron technique, the emission spectra for decay in luminescence curves were determined for this gas for pressures between 400 torr and 10 atmospheres. Comparison of experimental data and theoretical analysis enabled the elementary processes responsible for the emission to be studied. It was shown that the emission is due to excited argon molecules. The formation cross section and lifetime were determined for these molecules. (France)

**20872** X-RAY SPECTROSCOPIC STUDY OF HEAVY ION–ATOM COLLISIONS. Kamada, H.; Tamura, T.; Terasawa, M. (Tokyo Univ.). pp 341-552 of Sixth International Conference on X-Ray Optics and Microanalysis. Shinoda, G. (ed.). Tokyo; University of Tokyo Press (1972).

From proceedings of the sixth international conference on x-ray optics and microanalysis; Tokyo, Japan.

Experimental results on the excitation of K and L x-rays at the energy from 0.1 to 1.5 keV by the bombardment of $H^+$, $C^+$, $N^+$, $O^+$, $Ne^+$, and $Ar^+$ ions in the energy range of 20 to 500 keV are presented. The ions were obtained by using a 200 keV ion accelerator with PIG ion source. The x-rays were detected at 45° take-off angle with a gas-flow proportional counter. The measurement by nondispersion method and that with a flat-crystal diffraction spectrometer were carried out alternately. The ionization cross section of carbon K-shell was obtained for various ions. The cross sections in proton bombardment are in general agreement with theory. The data on heavy ions show larger cross section than the theory. The results of the cross section measurement of beryllium K-shell were similar to those for the carbon K-shell. The L-shell ionization cross section for various elements was quite similar to that for the K-shell ionization. The experimental results on the ionization cross section in heavy ion-atom collision may be understood within the framework of Fano–Lichten model. The spectra of heavy ion-induced x-ray measured with a diffraction spectrometer are shown. The observed spectra of heavy ion-induced C K x-ray show asymmetric profile, shift of peaks to higher energy side, and broadening in fwhm (full width at half maximum). In heavy ion-induced L x-ray spectra, two peaks appear corresponding to $L\alpha_{1,2}$ and $L\beta_1$. They did not show any shift, but the relative intensity of $L\beta_1$ line to $L\alpha_{1,2}$ line is very high in contrast with the spectra by protons or electrons. The spectra of heavy ion-induced x-rays change markedly, depending upon projectile and its bombarding energy. (Kato, T.)

**20873** LUMINESCENCE FROM $C^+(H_2,H)CH^+$ BELOW 20 eV. Harris, H.H. (Department of Chemistry, University of Missouri–St. Louis, St. Louis, Missouri 63121); Crowley, M.G.; Leventhal, J.J. Phys. Rev. Lett. 34: No. 2, 67-70 (13 Jan 1975).

Protons resulting from $C^+ - H_2$ collisions have been studied in order to determine which electronic states of the product $CH^+$ are formed. The $A^1\Pi$, $b^3\Sigma$, and $B^1\Delta$ states are observed; relative intensities depend on kinetic energy. No emission is unambiguously attributable to CH. These results complement earlier kinematic studies, and represent the first system for which luminescence has been used to distinguish among states suggested by kinematic analyses of reactive collisions. (auth)

**20874** OBSERVATION OF LARGE AND STRONGLY ENERGY DEPENDENT DIRECTIONAL ANISOTROPIES IN NONCHARACTERISTIC K X RAYS EMITTED IN HEAVY–ION COLLISIONS. Thoe, R.S.; Sellin, I.A.; Brown, M.D.; Forester, J.P.; Griffin, P.M.; Pegg, D.J.; Peterson, R.S. (University of Tennessee, Knoxville, Tennessee 37916). Phys. Rev. Lett. 34: No. 2, 64-67 (13 Jan 1975).

The existence of directional anisotropies in quasimolecular K–x–ray emission has been independently confirmed in experiments on the C–C, O–C, Al–Al and Si–Al collision systems. Anisotropies ranging from zero to substantially larger values than measured by Greenberg, Davis, and Vincent for the Ni–Ni system are strongly dependent on beam energy (0.06–2 MeV/amu). The C–C and O–C anisotropies decrease with energy. The Al–Al and Si–Al anisotropies increase with energy, in accord with a dependence predicted theoretically. (auth)

**20875** PRODUCTION MECHANISMS AND RADIATIVE LIFETIMES OF ARGON AND XENON MOLECULES EMITTING IN THE ULTRAVIOLET. Keto, J. W.; Gleason, R. E. Jr.; Walters, G. K. (Rice Univ., Houston, TX). Phys. Rev. Lett.; 33: No. 23, 1365-1368(2 Dec 1974).

The time dependences of uv emissions from dense argon and xenon are monitored following low intensity electron excitation. The uv transitions originate on the lowest $0_u^+$ and $1_u$ molecular states. For argon the radiative lifetimes are $3.2 \pm 0.3$ μsec ($1_u$) and $4.20 \pm 0.13$ nsec ($0_u^+$), while for xenon they are $96 \pm 5$ and $5.5 \pm 1.0$ nsec. The radiating molecules are formed by three-body destruction of excited atoms; the rate coefficient for argon is $(2.8 \pm 0.3) \times 10^{-33}$ $cm^6$/sec. (auth)

**20876** INDEPENDENT-PARTICLE-MODEL STUDY OF THE ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS BY POSITIVE IONS. Szydlik, P. P.; Kutcher, G. J.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A; 10: No. 5, 1623-1632(Nov 1974).

The elastic scattering by positive ions of electrons with energies below 2 Ry was investigated theoretically using the independent-particle-model (IPM) potentials of Green, Sellin, and Zachor to represent the electron-ion interaction. Parameters were determined from minimization of the total energy of the bound system consisting of the electron plus target ion, or in some cases from fits to the single-electron eigenvalues of this same system. Potentials of the former type are generally the stronger of the two. The IPM phase shifts versus energy are qualitatively similar to, but usually larger than, those obtained using Hartree-Fock-Slater potentials. For energies below 1 Ry there is excellent agreement between the differential cross sections for $Na^+$ obtained from the IPM and those computed from semiempirical quantum-defect methods. For this same ion the IPM differential cross sections likewise resemble those computed from Hartree-Fock potentials and lie between the Hartree-Fock results obtained with and without local exchange contributions. Phase shifts are computed using the independent-particle-model for all positive ions of nitrogen and oxygen, species of atmospheric interest. (auth)

**20877** ELECTRON-HYDROGEN RESONANCE CALCULATION BY THE COORDINATE-ROTATION METHOD. Doolen, G. D. (Texas A and M Univ., College Station); Nuttall, J.; Stagat, R. W. Phys. Rev., A; 10: No. 5, 1612-1615(Nov 1974).

The position and width of the lowest $^1S$ resonance in $e^-H$ scattering are calculated using the complex-coordinate-rotation method and compared with the results of other methods. (auth)

**20878** MATRIX VARIATIONAL CALCULATIONS OF ELECTRON SCATTERING BY C, N, AND O ATOMS. Thomas, L. D.; Oberoi, R. S.; Nesbet, R. K. (IBM Research Lab., San Jose, CA). Phys. Rev., A; 10: No. 5, 1605-1611(Nov 1974).

Total elastic cross sections for electron scattering by ground state C, N, and O atoms were computed by the matrix-variational method for energies up to the first n = 3 excitation. Two levels of approximation are considered: single configuration (SC) and near-degenerate configuration interaction (CI). Both approximations neglect the principal effects of target-atom electric-dipole polarizability. The SC calculations are the variational equivalent of earlier close-coupling calculations including all states of the ground configuration $2s^22p^m$. The CI calculations augment this with configurations $2s2p^{m+1}$ and $2p^{m+2}$. The short-range correlations introduced by the CI calculations are found to have dramatic effects on resonance structures found at low energies in SC calculations. In addition to the well established negative-ion bound states $C^-(^4S^0)$ bound and $O^-(^2P^0)$, the CI calculations give qualitative predictions of the true location of other $2s^22p^{m+1}$ states: $C^-(^2D^0)$ bound; $C^-(^2P^0)$ resonance near 1 eV; $N^-(^3P)$ very near threshold, either weakly bound or a very narrow resonance; no $O^-$ resonance. A method for precise location of these negative-ion states is proposed. (auth)

**20879** CHARGE-TRANSFER PROCESS USING THE MOLECULAR-WAVE-FUNCTION APPROACH: THE ASYMMETRIC CHARGE TRANSFER AND EXCITATION IN Li + $Na^+$ and Na + $Li^+$. Melius, C. F.; Goddard, W. A. III. (California Inst. of Tech., Pasadena). Phys. Rev., A; 10: No. 5, 1541-1558(Nov 1974).

The charge-transfer processes occurring in collisions of Li + $Na^+$ and Na + $Li^+$ were studied theoretically using the molecular-wave-function approach. The wave functions and Born-Oppenheimer breakdown terms were evaluated using rigorous methods. The six lowest molecular states (dissociating to the 2s and 2p atomic states on Li and to the 3s and 3p atomic states of Na) were included in the coupled equations. The transition probabilities were calculated using linear trajectories for a variety of impact parameters and ion velocities. That the over-all transition processes are well represented as a succession of simple two-state transition processes (Σ-Σ, Σ-Π, and Π-Π). The Σ-Σ two-state process can be described in terms of three steps involving a coupling region as the atoms come together [(10-20)$a_0$], an uncoupled phase changing region for shorter separations (<10$a_0$), and a decoupling region as the atoms depart [(10-20)$a_0$]. On the other hand, in the molecular-wave-function formulation, the Σ-Π two-state transition process involves continuous coupling (for R < 7$a_0$). As a result the transition probabilities for Σ-Π coupling differs from that of Σ-Σ coupling, leading to rather different forms for the cross sections. (auth)

**20880** ELECTRON TRANSFER INTO EXCITED STATES FOR $H^+$ AND $^4He^{++}$ COLLISIONS WITH ATOMIC HYDROGEN AND OTHER GASES. Khayrallah, G. A. New Haven; Yale Univ. (1974). 417p. University Microfilms Order No. 75-1371.

Thesis (Ph. D.).

Electron rearrangement processes involving collisions of a $^4He^{++}$ incident ion beam with low density $H_2$, $N_2$, Ar, He, and atomic hydrogen gas targets were studied experimentally. Measured were $\sigma_{21}$ (2s), the cross section for single electron-transfer into the 2s state of $He^+$ over the energy range 7 to 70 keV; $\sigma_{21}$, the total single electron-transfer cross section over the energy range 7 to 144 keV; and (except for H), $\sigma_{20}$, the total double electron-transfer cross section over the energy range 7 to 144 keV. The results for the single and double electron transfer cross sections for He and $N_2$ targets agree with previous $^3He^{++}$ experimental results of Berkner et al., when plotted as functions of incident ion velocity. At lower energies, the results for single electron-transfer from atomic hydrogen are in fair agreement with the $^3He^{++}$ results of Fite et al., after again scaling to the same incident ion velocity. Thus no large unexpected isotope effects are presently observed. Several theoretical results exist for the $^4He^{++}$-H(1s) collision system. The most recent is a closing-coupling-calculation involving eight atomic states. Such calculations were also performed for the $H^+$-H(1s) collision system. Much larger and more serious discrepancies between theory and experiment are observed in the present work on $^4He^{++}$-H(1s) collisions than is the case for the symmetric $H^+$-H(1s) collision system. In a separate but related experimental work, the study of keV $H^+$-H(1s) collisions were extended to the production by electron transfer of highly excited states with principal quantum numbers between 13 and 28. The sum of the cross sections over the observed quantum numbers was measured. The proton energy range was 7 to 60 keV. Possible error in the cross section scale is ± 30%. Presently obtained highly excited state results for $H^+$-Ar collisions are in agreement with previous experimental results. The data for $H^+$-H(1s) agree with the recent calculations of Band at 60 keV, but disagree by an order of magnitude with the results of the Brinkman-Kramer-Oppenheimer approximation. (Diss. Abstr. Int., B)

**20881** CALCULATION OF TOTAL ELECTRON EXCITATION CROSS-SECTIONS AND PARTIAL ELECTRON IONIZATION CROSS-SECTIONS FOR THE ELEMENTS. Greene, T. J. Toledo; Univ. of Toledo (1973). 217p. University Microfilms Order No. 74-29,744.

Thesis (Ph. D.).

Computer programs are used to calculate the total electron excitation cross section for atoms and the partial ionization cross section. The calculation is done in the following manner. Each of the approximations listed below results in an expression for a scattering amplitude, involving the atomic wave function of the target. These amplitudes are simply related to the differential cross sections which are integrated to give the total excitation (or partial ionization) cross section for the collision. The approximations to the scattering amplitude used are nonexchange excitation: Born, Bethe, and modified Bethe; exchange excitation: ochkur; nonexchange ionization: coulomb-born. The atomic wave functions used are Hartree-Fock-Slater, (HFS) functions for bound states and the Coulomb wave function for the continuum. The programs are presented and some results are examined. (Diss. Abstr. Int., B)

**20882** ENERGY TRANSFER IN ATOM-RIGID ROTOR COLLISIONS: A TWO-DIMENSIONAL QUANTUM-MECHANICAL TREATMENT. Dillon, H. K. Nashville; Vanderbilt Univ. (1974). 124p. University Microfilms Order No. 75-1132.

Thesis (Ph. D.).

A quantum-mechanical treatment was developed which describes the rotational-translational energy transfer occurring as the result of the collision of an atom with a rigid diatomic rotor in two dimensions. The method follows the time-independent formulation of scattering theory. The intermolecular potential is a sum of step functions of the relative motion coordinate with the center of mass of the rotor as origin. Segmentation of the potential in this way allows solution of the Schroedinger equation by separation of variables within each of several regions into which the space of the system is divided. Solution of the angular equation produced by separation of variables requires the Fourier expansion of the angularly anisotropic term of the intermolecular potential within each region. Boundary conditions shared by neighboring regions lead to systems of linear equations which determine transition probabilities. The greater probability of multiquantum transitions for the He-HD system than for the He-$H_2$ system for similar collisional energies seems to be primarily a result of the greater number of energetically accessible states in the former system. The effects of varying potential well depth and also mass of the incident atom were also investigated. Inelasticity of collision increases with increase in magnitude of the Lennard-Jones potential well depth and increase in mass of the incident atom. (Diss. Abstr. Int., B)

**20883** SPIN, POLARIZATION, AND COHERENCE EFFECTS IN ELECTRON-ATOM COLLISION PROCESSES. Kleinpoppen, H. (Stirling Univ., Scotland). Int. J. Quant. Chem., Symp.; No. 8, 59-72(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

A summary is given of some of the most important recent results on spin, polarization, and coherence effects in electron-atom collisions with restriction to some typical characteristics. (JFP)

**20884** MULTIPLE SCATTERING THEORY BEYOND THE MUFFIN-TIN APPROXIMATION. Williams, A. R. (IBM Watson Research Center, Yorktown Heights, NY). Int. J. Quant. Chem., Symp.; No. 8, 89-108(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Multiple scattering theory appears to be the most efficient means of extracting the chemical and physical implications of the density functional method developed by Slater and by Hohenberg, Kohn and Sham for the study of inhomogeneous many-electron systems. The implications of this approach to electronic exchange and correlation were obscured by the almost universal use of the muffin-tin approximation in the application of multiple scattering theory. It is contended that an understanding of the sources of the efficiency of multiple scattering theory leads directly to a particular method of eliminating the muffin-tin approximation. (auth)

**20885** INTERACTION POTENTIALS AND DYNAMICS FOR Li + F COLLISIONS. Redmon, M. J.; Micha, D. A. (Univ. of

Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 8, 253-262(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Diabatic potential curves are presented for $^1\Sigma$ states of LiF and integral cross sections for elastic scattering of $Li(^2S) + F(^2P)$ at thermal collision energies. Potential curves were obtained using atomic pseudopotentials and the extended valence-bond method. Pairs of coupled scattering equations were numerically integrated with a recently developed approach. Comparison of cross sections for homopolar (single channel) and homopolar plus ionic (two coupled channels) interactions provides information on the electron jump mechanism during collision. (auth)

**20886** RECENT DEVELOPMENTS IN THE THEORY OF REACTIVE MOLECULAR COLLISIONS. Micha, D. A. (Univ. of Florida, Gainesville). Int. J. Quant. Chem., Symp.; No. 8, 263-269(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

A summary is presented of recent developments on reactive collisions involving trajectory studies, computer modeling, statistical approaches, the coupled-channel method and approximations, and many-body theories. (auth)

**20887** POLARIZED PHOTON CORRELATION STUDIES IN $He^+ + He$ COLLISIONS. De Rijk, W. G. W. J. Lincoln, NE; Univ. of Nebraska (1974). 85p. University Microfilms Order No. 75-3417.

Thesis (Ph. D).

An apparatus was designed and constructed to study the $He^+ + He$ charge transfer process using the delayed coincidence technique. The polarization of the radiation emitted was measured to determine the relative phase between the collision amplitudes $a_0$ and $a_1$, and the relative magnitudes of the corresponding partial cross sections $\sigma_0$ and $\sigma_1$. The cross sections $\sigma_0$ and $\sigma_1$ express the probability of excitation of magnetic substates with $M_L = 0$ and $M_L = \pm 1$ respectively. The transition studied was the $3^1P - 2^1S$ in helium. The experiment was performed with a $\varphi_2$ T of 3 keV degree which corresponds to an impact parameter of 0.46 Å, or a distance of closest approach of 0.47 Å. A beam of $He^+$ ions of 3 keV was introduced into a helium filled interaction area, and the scattered particles and radiation of $\lambda = 3889$ Å produced in the interaction area were observed with suitable detectors. Coincidence circuitry employing negative logic was used to select the He ions which had acquired an electron in the $3^1P$ state and were simultaneously scattered into an angle of one degree. The polarization of the resulting radiation was measured from 0 to 180°, with respect to the incident beam. The results indicated that rotational coupling between the particles did occur and that transitions with $\Delta M_L = \pm 1$ were present. The ratio of the partial cross sections was $\sigma_0/\sigma_1 = 2.1$. The relative phase difference between transitions with $\Delta M_L = 0$ and $\Delta M_L = \pm 1$ was found to be 136°. The collision amplitudes were expressed directly in terms of coincidence rates, a result obtained from the radiation particle-coincidence theory as developed by J. Macek and D. H. Jaecks. Some elongation was observed in the polarized radiation pattern at a polarization angle of 135° with respect to the incident beam, which is considered to be a contribution from scattering processes at angles other than 1° due to the finite width of the scattered particle detector. (Diss. Abstr. Int., B)

**20888** CHARACTERISTIC AND NON-CHARACTERISTIC X RAYS FROM ION-ATOM COLLISIONS. Oona, H. Tucson, AZ; Univ. of Arizona (1974). 135p. University Microfilms Order No. 75-4124.

Thesis (Ph. D.).

An x-ray station has been developed at The University of Arizona beam-foil laboratory to extend spectral studies into the x-ray region ($\lambda$ 0.5 Å → 100 Å). The station consists of a Bragg-diffraction crystal spectrometer modified to give high (1 eV) resolution, and a solid state Si(Li) detector for high quantum efficiency. Both spectrometers have been used to study gas and solid targets. High resolution studies of Ar x-ray satellite spectra have provided insight to the problem of Ar L-shell fluorescence yields. High resolution work of B K x rays provided information about H-like, He-like, and Li-like B. Results of these studies give additional validity to the electron promotion schemes of Fano and Lichten. Cross section studies of $Ar^+ \rightarrow Ar$, $Cl^+ \rightarrow Ar$, and $Cl^+ \rightarrow Cl_2$ have demonstrated the importance of outer shell ionization for inner shell x-ray energies. Two sources of noncharacteristic x rays were investigated. One arises from the coupling of characteristic x rays to plasma oscillations in solids. The other arises from emission from quasimolecular (united-atom) systems that produce a continuum of x rays. Observation of these in $O^+ \rightarrow O$ and $Ne^+ \rightarrow Ne$ have added impetus to the united-atom x rays. (Diss. Abstr. Int., B)

## Atomic Theory

*Refer also to abstracts 20857, 21312, and 21333.*

**20889** (FUPH-R-111) (e,2e) EXPERIMENT AS A PROBE FOR ELECTRON MOMENTUM DENSITY. Weigold, E.; McCarthy, I. E. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Nov 1974. 18p. Dep. NTIS (US Sales Only) $4.00.

Details are given of the (e,2e) experiment and the method of extracting information from it concerning valence electron momentum density in atoms and molecules. The format is governed by the requirements of the ad-interim commission on electron charge, spin and momentum density project on momentum space experiments. In addition it is pointed out that much more information is available than merely electron momentum density. The experiment directly measures single particle wave functions, spectroscopic factors describing configuration interaction in ions, single particle separation energies for correlated ion states, and information about ground state correlations. (auth)

**20890** CHARGE TRANSFER INTO HIGHLY EXCITED STATES OF HYDROGENLIKE ATOMS AT HIGH VELOCITIES. Shakeshaft, R. (New York Univ.). Phys. Rev., A; 10: No. 5, 1906-1907 (Nov 1974).

It is generally thought that in the high velocity limit the dominant contribution to the cross section for charge transfer (in the forward direction) comes from a particular second Born term. It is shown that for charge transfer into states of hydrogenlike atoms the particular second Born contribution which dominates in the high velocity limit decreases as $n^{-3}$ in the limit of high principal quantum number n. (auth)

**20891** FINE STRUCTURE, HYPERFINE STRUCTURE, AND LAMB SHIFT MEASUREMENTS BY THE BEAM-FOIL TECHNIQUE. Andrea, H. J. (Freie Univ. Berlin). Phys. Scr.; 9: No. 5, 257-280(May 1974).

From 5th annual conference of the European Group for Atomic Spectroscopy; Lund, Sweden (10 Jul 1973).

A survey on high resolution experiments with atomic systems prepared by the beam-foil or beam-gas interaction is presented. Rf-resonance field-quenching, quantum-beat and level-crossing experiments are described in elementary terms whereas more advanced theoretical techniques are sketched for quantum beats. (auth)

**20892** APPLICATIONS OF SYNCHROTRON RADIATIONS TO ATOMIC, MOLECULAR, AND SOLID STATE SPECTROSCOPY. Codling, K. (Univ. of Reading, Eng.). Phys. Scr.; 9: No. 5, 247-256(May 1974).

From 5th annual conference of the European Group for Atomic Spectroscopy; Lund, Sweden (10 Jul 1973).

Synchrotron radiation is emitted when electrons are subjected to centripetal acceleration in synchrotrons and storage rings. The properties of the radiation which make it a unique source for spectroscopy in the extreme ultraviolet (1000 to 10 Å) and x-ray regions are briefly described. The kinds of experiments that benefit substantially from this intense, highly polarized, pure continuum are listed. Photoelectron spectroscopy is taken as an example of a specific technique where the application of synchrotron radiation will make a considerable impact. (auth)

**20893** GENERALIZATION OF THE HARTREE-FOCK ONE PARTICLE POTENTIAL. Day, O. W. (Univ. of Georgia, Athens); Smith, D. W.; Garrod, C. Int. J. Quant. Chem., Symp.; No. 8, 501-509(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

By making the assumption that the addition (subtraction) of an electron from a many-body wave function may be represented by a single spin orbital, variationally determined, two distinct one-particle potentials are derived. They represent, respectively, the effective interaction of the (N - 1)-electron system with the Nth electron, and the effective interaction of the N-electron system with the (N + 1)th electron. Nonlocal exchange arises because of the indistinguishability of electrons. The "core" electrons are allowed to be correlated with each other and to be polarized by the electron in question. Eigenvalues to these potentials represent, respectively, ionization potentials and electron affinities, and the eigenfunctions are variationally determined spin orbitals ("standing-wave solutions"), termed the "natural transition orbitals." The two-body density matrix of a reference state approximating an eigenfunction of the many-body Hamiltonian

is required as input to the theory. Given this input, the method is linear, requiring no interactions. In the limit of no correlation in the reference N-body state (provided the occupied orbitals span the Hartree–Fock space), the two potentials reduce to the unrestricted Hartree–Fock potential for occupied and virtual orbitals. (auth)

**20894** LEVEL-DEPENDENT NEW TAMM–DANCOFF CALCULATIONS. Henkel, J. H. (Aerospace Research Labs., Wright-Patterson AFB, OH); Uzes, C. A. Int. J. Quant. Chem., Symp.; No. 8, 73-79(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Excitation energies using the level-dependent new Tamm–Dancoff method are calculated for four one-dimensional symmetric anharmonic oscillators. Convergence of the calculated excitations is demonstrated numerically and compared with the excitations obtained by integrating Schrödinger's equation numerically. The treatment is developed to illustrate how expansions other than level-dependent Wick expansions may be used to transform the T-recursion system into the $\phi$-recursion system. Specifically, numerical results for adjacent energy level differences for the sixth-degree oscillator are obtained using numerical solutions of the fourth-degree oscillator to construct the transformation that carries the T-recursion system into a $\phi$-recursion system. (auth)

**20895** MULTICONFIGURATION HARTREE–FOCK APPROACH TO ATOMIC STRUCTURE CALCULATIONS. Fischer, C. F. (Univ. of Waterloo, Ontario). Int. J. Quant. Chem., Symp.; No. 8, 5-15(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

A numerical multiconfiguration Hartree–Fock (MCHF) approach to atomic structure calculations is described. (auth)

**20896** EFFECT OF ELECTRON CORRELATION ON ATOMIC PROPERTIES. Beck, D. R.; Nicolaides, C. A. (Yale Univ., New Haven). Int. J. Quant. Chem., Symp.; No. 8, 17-28(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

The object is threefold, (a) to establish how nonrelativistic correlation theories may be applied to any atom of the periodic table; (b) to formulate a procedure based on a definition of the "Fermi sea" for predicting the importance of correlation effects on atomic properties other than total energies; and (c) to present new results on 1s binding energies in C, F, $F^-$, Ne, Na, and $Na^+$, $KL_1L_1$ Auger energies in C and O, lifetimes in the Si $3s3p^3\ ^3D^0 \rightarrow 3s^23p^2\ ^3P$ isoelectronic sequence, and the hyperfine structure of Be and B $1s^22p\ ^2P^0$ states, which not only are of interest in themselves but illustrate points (a) and (b) above. (auth)

**20897** SUGGESTED APPLICATIONS OF THE DENSITY MATRIX. Peat, F. D. (National Research Council of Canada, Ottawa). Int. J. Quant. Chem., Symp.; No. 8, 313-321(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

It is suggested that the limited success which has been the fate of density matrix techniques is a feature not of their inherent limitations but of the restricted class of problems which have been approached. Alternative theoretical techniques in atomic, molecular, and solid-state studies are proposed, which are grounded in the density matrix formalism, and suggestions are made for new fields in which density matrix methods may expand. (auth)

**20898** UNITARY GROUP FORMULATION OF THE N-PARTICLE PROBLEM. Matsen, F. A. (Univ. of Texas, Austin). Int. J. Quant. Chem., Symp.; No. 8, 379-388(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974)

The representation of an N-particle Hamiltonian on an Nth rank orbital product space is exactly modeled by a second-degree polynomial in the infinitesimal generators of the unitary group. Symmetry adaptation of the product space with respect to the symmetric group yields Gel'fand states which are bases for the irreducible representations of the unitary group. These exist in closed form, as, in consequence, does the representation of the model Hamiltonian. The exclusion principle is imposed by restricting the irreducible representations of the unitary group. The unitary group formulation is equivalent to standard many-body theory for the particle-conserving case. (auth)

# PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

**20899** AXISYMMETRIC MAGNETOGASDYNAMIC FLOWS. Colwell, D. J. (North Staffordshire Polytechnic, Stafford, UK). Z. Angew. Math. Phys.; 25: No. 1, 55-62(25 Jan 1974).

The equations governing axisymmetric, magnetogasdynamic flows are reduced to azimuth-independent form. From this form, in the case of steady flows, some well-known theorems and particular solutions are deduced and in several instances are generalized. Finally, unsteady, axisymmetric flows are considered. (auth)

**20900** PERIODIC FLUID TRANSIENTS IN RECTANGULAR DUCTS WITH TRANSVERSE MAGNETIC FIELDS. Walker, J. S. (Illinois Univ., Urbana (USA). Dept. of Theoretical and Applied Mechanics). Z. Angew. Math. Phys.; 25: No. 3, 355-366(25 May 1974).

This paper treats periodic fluid transients in liquid metals contained in constant-area rectangular ducts with uniform, transverse, applied magnetic fields. The magnetic Reynolds and Mach numbers are assumed to be small, and the Reynolds number is assumed to be large. Two separate families of discrete wave numbers are found for ducts with perfectly conducting sides (parallel to the applied magnetic field) and either perfectly conducting or insulating top and bottom. The dispersion relation is found for the wave modes in fully insulating ducts, and its numerical solution is outlined. Solutions are also given for the viscous boundary layers which match the inviscid wave modes in fully conducting ducts, these being typical of boundary layers in any rectangular duct. (auth)

**20901** MAGNETOHYDRODYNAMIC FLOW PAST A CIRCULAR CYLINDER. Bramley, J. S. (Strathclyde Univ., Glasgow (UK). Dept. of Mathematics). Z. Angew. Math. Phys.; 25: No. 3, 409-416(25 May 1974).

The steady, two-dimensional imcompressible MHD flow past a circular cylinder with an applied magnetic field parallel to the main flow is calculated using the method of series truncation. The differential equations are solved analytically and the Oseen approximation is made. The magnetic Reynolds number is assumed to be small. The results show that with an applied magnetic field the flow stays attached to the cylinder longer and in some cases does not separate until the rear stagnation point. (auth)

**20902** FREE CONVECTION EFFECTS ON STEADY MHD FLOW PAST A VERTICAL POROUS PLATE. Soundalgekar, V. M. (University Coll. of South Wales and Monmouthshire, Eng.). J. Fluid Mech.; 66: 541-551(25 Nov 1974).

An analysis of two-dimensional steady flow of an incompressible, viscous, electrically conducting fluid past an infinite vertical porous plate is carried out under the following assumptions: (i) that the suction velocity normal to the plate is constant, (ii) that the plate temperature is constant, (iii) that the difference between the temperatures of the plate and the free stream is moderately large, causing free convection currents, (iv) that the transversely applied magnetic field and magnetic Reynolds number are very small and hence the induced magnetic field is negligible. Approximate solutions to the coupled nonlinear equations governing the steady velocity and temperature are derived. They are shown graphically. During the course of discussion, the effects of positive and negative G (the Grashof number: $G > 0$ implies cooling of the plate, $G < 0$ heating of the plate), of P (the Prandtl number), of positive and negative E (the Eckert number) and of M (the magnetic field parameter) are presented quantitatively. (auth)

# PHYSICS (HIGH-ENERGY)

## Particle Interactions and Properties (Experimental)

*Refer also to abstracts 19949 and 21251.*

**20903** (CONF-740685-(Absts.)) GENERAL SCIENTIFIC MEETING OF THE BELGIAN PHYSICAL SOCIETY, MONS, BELGIUM, JUNE 6-7, 1974. Abstracts. (Societe Belge de Physique, Mol; Mons Univ. (Belgium)). 1974. 83p. (In several languages).

The meeting consisted of papers on the following subjects: physics of the solid state (26), physics of elementary particles (18), atomic and molecular physics and physics of plasmas (18), and nuclear physics (11). Abstracts appear in English, Dutch, or French. (RWR)

**20904** NAL EXPERIMENTAL PROGRAM. Walker, J. K. (National Accelerator Lab., Batavia, IL). pp 515-537 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The progress on the machine development and the proposed experiments are summarized including hadron, electromagnetic, and neutrino interactions. (JFP)

### *Electromagnetic*

*Refer also to abstracts 19742, 19743, and 19748.*

**20905** (JINR-P13-8368) CONTROL OF A DETECTOR OPERATION IN THE $\pi$-e SCATTERING EXPERIMENT AT 50 GeV. Adylov, G. T.; Aliev, F. K.; Vodop'yanov, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The operation of the setup in the $\pi$-e scattering experiment is controlled by means of "on-line" programs on an HP2116B computer. The results were presented as 200 histograms or numeral tables; an operator could transmit each of them to a display or a printer. The performance of the counters and the trigger system was presented in the "on-line" analysis by the pulse histograms of each photomultiplier in the setup, pulse amplitude spectra of the Cerenkov spectrometers, overlap distribution of the counter pulses which trigger the setup. Besides, the two-dimensional count distribution was transmitted which characterized the linearity of the Cerenkov spectrometers, and the count rate of 13 elements of fast electronics was registered as well. (auth)

**20906** RECOIL HADRON ANGULAR DISTRIBUTIONS IN MUON–PROTON DEEP–INELASTIC SCATTERING. Murtagh, M.; Gittleson, H.; Kirk, T.; Tannenbaum, M.J.; Lederman, L.M.; Limon, P.; May, M.; Rapp, P.; Sculli, J.; White, T.; Yamanouchi, T.; Entenberg, A.; Jöstlein, H.; Kostoulas, I.; Melissinos, A.C. (Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 10: No. 11, 3873-3876 (1 Dec 1974).

The angular distribution of hadrons produced in muon–proton inelastic scattering is measured. The interacting virtual photons are in the kinematic region $0.4 < q^2 < 3.0$ (GeV/c)$^2$, $1.4 < W < 3.5$ GeV. For $W > 2.5$ GeV the angular distribution does not appear to depend on $q^2$. For W less than 2.5 GeV, the angular distribution at fixed W possibly shows a $q^2$ dependence which is less pronounced when the angular distribution is taken at fixed $\omega$. Integration of the angular distributions gives a charged–particle multiplicity in agreement with other experiment results. (auth)

**20907** POSSIBLE EVIDENCE FOR MANY-PARTICLE PROCESSES IN ELECTROMAGNETIC INTERACTIONS OF MUONS. Erlykin, A. D.; Kulichenko, A. K.; Machavariani, S. K.; Nikol'skii, S. I. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 173-176(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1084-1088(1974).

An experimental study is made of the differential energy spectra and angular distributions of cascades generated by muons in lead near the vertical. (JFP)

**20908** SPATIAL DISTRIBUTION OF THE EAS MUON COMPONENT AT MOUNTAIN LEVEL. Georgiev, N.; Stamenov, I.; Yanminchev, V.; Bobova, V. P.; Kabanova, N. V.; Romakhin, V. A. (Inst. of Nuclear Research and Nuclear Energetics, Sofia). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 169-172 (1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1079-1083(1974).

A joint effort by the P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, and the Institute of Nuclear Research and Nuclear Energetics, Bulgarian Academy of Sciences, over the period 1971-1973 significantly increased the sensitive area of the hodoscopic electron and muon detectors at the Tyan–Shan apparatus complex. Data were obtained on the spatial distribution of the muon flux and the muon energy spectrum far from the shower axis. (auth)

**20909** CERTAIN CHARACTERISTICS OF THE EAS MUON COMPONENT AT MOUNTAIN LEVEL. Betev, B.; Georgiev, N.; Stamenov, I.; Stanev, T.; Yanminchev, V.; Kabanova, N. V.; Nikol'skaya, N. M. (Inst. of Nuclear Research and Nuclear Energetics, Sofia). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 166-168(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1076-1078(1974).

Fluctuations in the total number of muons having energies above 5 GeV for a fixed number of shower particles are analyzed on the basis of experimental data obtained through collaboration of the P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, and the Institute of Nuclear Research and Nuclear Energetics, Bulgarian Academy of Sciences, as part of an effort to study the EAS muon component. The average muon density at a distance of 30 to 50 m from the shower axis and that at a distance $< 15$ m from the axis are studied as functions of the total number of shower particles. The muon density for distances in the range 30 to 50 m is found to vary as the shower size is increased. (auth)

**20910** EXPERIMENTAL STUDY OF TRANSITION EFFECTS IN ELECTRON–PHOTON CASCADES. Kol'chuzhkin, A. M.; Ryzhov, V. V.; Shoshin, E. B. (Tomsk Polytechnical Inst., USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 144-146(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1052-1055(1974).

Transition effects in absorbers consisting of layers of lead and copper were measured. The experiments were carried out in an electron synchrotron at maximum bremsstrahlung energies of 600 and 950 MeV. The experimental results agree qualitatively with theoretical calculations for transition effects. (auth)

**20911** DEVELOPMENT OF ELECTROMAGNETIC CASCADES IN LEAD IN THE ENERGY RANGE 20 TO 100 GeV. Azimov, S. A.; Daudov, Z. Kh.; Kochetkov, G. A.; Kratenko, Yu. P.; Levkovich, S. G. (State Univ., Tashkent). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 142-143(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1050-1051(1974).

Average cascade curves in lead due to primary electrons and photons having energies in the range 20 to 50 GeV were obtained with an ionization calorimeter. The particle distribution function at the maximum of the cascade curve and the fluctuations in the course of the curves were studied. (auth)

**20912** SPATIAL DISTRIBUTION OF ELECTRONS AND MUONS IN EXTENSIVE AIR SHOWERS. Khristiansen, G. B.; Kulikov, G. V.; Solov'eva, V. I. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 114-117(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1020-1023(1974).

New experimental data are reported on the structure functions of muons and electrons in extensive air showers. (auth)

**20913** CERTAIN CHARACTERISTICS OF HORIZONTAL AIR SHOWERS. Baranik, A. T.; Volovik, V. D.; Zalyubovskii, I. I.; Kaminskii, A. T.; Kartashev, V. M.; Knysh, V. A. (Kharkov State Univ.). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 111-113(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1017-1019(1974).

The properties of horizontal air showers studied include the distribution of these showers with respect to zenith angle and age and the integral spectrum of showers with respect to the number of particles. (JFP)

**20914** SPECTRAL DISTRIBUTION OF THE RADIO EMISSION OF EXTENSIVE AIR SHOWERS. Volovik, V. D.; Zalyubovskii, I. I.; Levchenko, V. N.; Sogokon, S. I.; Khirnyi, A. I.; Shmatko, E. S. (Kharkov State Univ.). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 108-110(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1013-1016(1974).

Experimental data obtained on the apparatus of Khar'kov University are reported. The measurements were carried out at 34, 40, 52, 95, 118, 135, and 162 MHz. Five showers accompanied by radio emission were detected in 1150 hr. (auth)

**20915** MULTIPLE-CORE PROBLEM IN EXTENSIVE AIR SHOWERS. Stanev, T.; Markovskii, B. (Inst. of Nuclear Research and Nuclear Energetics, Sofia). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 103-107(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1007-1012(1974).

A multifaceted study of the electron-photon, nuclear-active and muon components was carried out in order to determine the characteristics of multiple-core showers. Experimental results obtained in the detection of extensive air showers at the Tyan-Shan apparatus complex imply a significant difference between multiple-core showers and showers having a normal structure of the electron-photon component. Processes which could furnish an explanation for multiple cores are discussed. (auth)

**20916** DISTRIBUTION OF SHOWERS WITH RESPECT TO THE NUMBER OF PARTICLES AT 1850 m.a.s.l. Apshev, S. Zh.; Bridenko, I. I.; Stamenov, I. N.; Tsagova, L. Z. Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 99-102(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1003-1006(1974).

Showers having $N = 5 \cdot 10^3$ to $3.2 \cdot 10^5$ particles were studied. The integral distribution of the showers with respect to the number of particles is plotted. The experimental results are compared with the results of other studies. (auth)

**20917** ENERGY-FLUX ABSORPTION IN THE CORES OF EXTENSIVE AIR SHOWERS. Aseikin, V. S.; Bobova, V. P.; Georgiev, N. Kh. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 94-98 (1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 998-1102(1974).

In a study of the spectrum of the ionization bursts caused by the hadrons of extensive air showers at various absorber depths, attention is focused on the anomalously slow energy-flux absorption in the cores of extensive air showers. Analysis of the energy-flux absorption curves in individual showers furnishes evidence in favor of a change in the shower composition in the interactions of very-high-energy hadrons. (auth)

**20918** RELATION BETWEEN THE NUMBER OF PARTICLES IN AN EXTENSIVE AIR SHOWER AT SEA LEVEL AND THE ENERGY OF THE PRIMARY PARTICLE FOR $E_0 \geq 10^{17}$ eV. D'yakonov, M. N.; Kershengol'ts, I. M.; Kozlov, V. I. (Inst. of Cosmic Physics Research and Aeronomy, Novosibirsk, USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 89-93(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 993-997(1974).

Experimental data obtained in extensive air shower observations was processed by adopting an a priori spatial distribution for the shower particles in a form given previously, taking into account the conversion to sea level. Also an attempt was made to determine the spatial distribution of the particles independently of the previous form. The various spatial distributions, differential EAS spectrum, results of calculations on the basis of various models are discussed. (JFP)

**20919** STRATOSPHERIC MEASUREMENTS OF COSMIC-RAY SHOWERS ARISING AT LEAD NUCLEI. Charakhch'yan, A. N.; Stozhkov, Yu. I.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 43-48(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 944-949(1974).

Stratospheric measurements were carried out by means of portable cosmic-ray radiosondes carried on balloons. The data indicate that the interaction of protons at energies above 13 GeV with lead nuclei results in the production of about four times as many cascade protons as in the corresponding interactions of protons with silver or bromine nuclei. (auth)

**20920** EXPERIMENTAL DATA ON $\gamma$ AND HADRON FAMILIES AND $\gamma$ AND HADRON SPECTRA. The Pamir Experiment. Anitschenko, Yu. V. (Lebedev Inst. of Physics, Moscow); Dobrotin, N. A.; Zelevinskaya, N. G. Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 19-23(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 918-922(1974).

The differential energy spectrum of the cosmic-ray electron-photon component and the integral energy spectrum of the hadron component were obtained over the energy range 2 to 20 TeV. Comparison with the calorimetric data shows that the effective threshold for the detection of hadrons is 8 to 10 TeV. The characteristics of the groups ("families") of $\gamma$ rays and hadrons and the correlations between them are reported. (auth)

**20921** ANALYSIS OF NUCLEAR INTERACTIONS DETECTED BY X-RAY EMULSION CHAMBERS. Takibaev, Zh. S.; Emel'yanov, Yu. A.; Zaitseva, E. G.; Kvochkina, T. N.; Lukin, Yu. T.; Sadykov, T. Kh. (Inst. of High-Energy Physics, Alma-Ata, USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 9-12(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 907-911(1974).

The accuracy of the photometric method for determining the energy of an isolated $\gamma$ ray in x-ray film was evaluated. The calibration was based on the kinematics for $\pi^0 \rightarrow 2\gamma$ decay. An analysis is made of families of $\gamma$ rays having total energies $\Sigma E_\gamma$ from 8 to 35 TeV. Over this $\Sigma E_\gamma$ range the mass of the system which appears in the neutral component is $m_\gamma = 1.0$ GeV. (auth)

**20922** POLARIZED GAMMA QUANTA PRODUCTION IN LIGHT PHOTON SCATTERING ON ELECTRONS ACCELERATED BY THE SIRIUS SYNCHROTRON. Peshkov, A. V.; Kalinin, B. N.; Aleksandrov, E. I.; Karakutsev, A. V. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 44-46(1973). (In Russian).

The production of polarized $\gamma$ quanta by the Compton scattering of laser radiation on 1 to 1.5 GeV electrons accelerated in the Sirius synchrotron was experimentally studied. (tr-auth)

**20923** EXPERIMENTAL STUDY OF THE NEW 3.1 GeV PARTICLE BY $e^+e^-$ COLLISION AT ADONE. Ash, W. W. (CNEN, Rome); Cheng, D. C.; Esposito, B. Lett. Nuovo Cim.; 11: No. 17, 705-710(28 Dec 1974).

Preliminary results of an investigation of electron-positron annihilation in the total cm energy $\sqrt{s} = (3.09 \pm 3.112)$ GeV for the channels $e^+e^- \rightarrow e^+e^-$, $e^+e^- \rightarrow \mu^+\mu^-$, and $e^+e^- \rightarrow$ many hadrons are presented. A very narrow resonant behavior of the cross section for these processes is confirmed. The total hadronic cross section integrated over the energy is $\sigma = (4.7 \pm 1.6)\ 10^{-33}$ cm$^2$ GeV. The rates, total cross sections for multihadron production, and the angular distribution are discussed. (JFP)

**20924** PRELIMINARY RESULTS ON THE ENERGY DEPENDENCE OF THE PRODUCTION OF COLLINEAR RELATIVISTIC PARTICLES AT ADONE IN THE 3.1 GeV C.M. ENERGY REGION. Barbiellini, G. (CNEN, Rome); Nicoletti, G.; Bararino, G Lett. Nuovo Cim.; 11: No. 17, 718-722(28 Dec 1974).

Data are presented on the energy dependence of the production probability of electron pairs around 3.1 GeV total energy in the angular region from 44 to 136° with respect to the direction of the beams. The yields from these events are plotted. (JFP)

**20925** ELASTIC SCATTERING OF ELECTRONS AND POSITRONS FROM PROTONS. Hartwig, S. (Univ., Freiburg); Heimlich, F. H.; Huber, G.; Roessle, E.; Koebberling, M.; Moritz, J.; Schmidt, K. H.; Wegener, D.; Zeller, D.; Bleckwenn, J. Lett. Nuovo Cim.; 12: No. 1, 30-32(4 Jan 1975).

In the derivation of the Rosenbluth formula, it is assumed that the contributions of the two-photon exchange graphs are negligible. But it cannot be excluded that intermediate resonance amplitudes may depend on $q^2$ and $\theta$. Thus a test of their existence requires measurements in as large as possible a range of those parameters. To determine those parameters the ratio $R = \sigma(e^+ + p)/\sigma(e^- + p) = \sigma^+/\sigma^-$ is measured and calculated for three $q^2$ and $\theta$ values beyond the range covered so far. It is found that

within the accuracy of the measurement the ratio R is equal to 1. Thus there is no evidence for an anomalous two-photon effect in the region of the $q^2$ values concerned. (JFP)

**20926** MULTIREACTION SPALLATION DETECTORS FOR MEASURING FLUXES AND ENERGY SPECTRA OF HIGH ENERGY HADRONS. Routti, J. T. (Helsinki Univ. of Tech., Otaniemi, Finland). Phys. Scr.; 10: No. 3, 107-114(Sep 1974).

A method is described for measuring fluxes and energy spectra of high energy hadron cascade particles in the energy range of tens to hundreds of MeV. A multitude of spallation reactions induced in copper foils are identified and quantitatively measured by the use of high resolution Ge(Li) gamma spectroscopy and computerized analysis. Calculated spallation cross sections are used to estimate hadron fluxes above different threshold energies and to determine the energy spectra of these particles. Results obtained with high energy proton accelerators are presented and compared with hadron cascade calculations. (auth)

## Weak

*Refer also to abstract 21066.*

**20927** (COO-3071-112) FLUX INDEPENDENT SEARCH FOR NEW PARTICLE PRODUCTION IN HIGH ENERGY NEUTRINO AND ANTINEUTRINO COLLISIONS. Benvenuti, A.; Cline, D.; Ford, W. T.; Imlay, R.; Ling, T. Y.; Mann, A. K.; Messing, F.; Reeder, D. D.; Rubbia, C.; Stefanski, R.; Sulak, L. (Harvard Univ., Cambridge, Mass. (USA); Pennsylvania Univ., Philadelphia (USA); Wisconsin Univ., Madison (USA); Fermi National Accelerator Lab., Batavia, Ill. (USA)). 19 Nov 1974. Contract AT(11-1)-3071. 14p. Dep. NTIS $4.00.

Experimental distributions of flux independent variables obtained from high energy neutrino and antineutrino collisions are presented. Some of these data appear to be inconsistent with the simplest theoretical predictions based on Bjorken scaling. If the deviations are due to a propagator modification of the weak interaction or failure of Bjorken scaling (neglecting radiative corrections), the characteristic mass is within the limits of 12 to approximately 25 GeV at the 99% confidence level. If the disagreement is due to new particle production, the mass of this particle is less than or in the vicinity of 7 GeV. (auth)

**20928** OBSERVATION OF RARE DECAY MODES OF THE $\Xi$ HYPERONS. Yeh, N.; Gaigalas, A.; Smith, W.D.; Zendle, H. (Physics Department, State University of New York at Binghamton, Binghamton, New York 13901); Baltay, C.; Bridgewater, A.; Csorna, S.; Cooper, W.A.; Gershwin, L.K.; Habibi, M.; Kalelkar, M. Phys. Rev. D 10: No. 11, 3545-3555 (1 Dec 1974).

In an experiment based on the production of 8150 $\Xi^-$ and 2975 $\Xi^0$ hyperons, we have detected one example each of the decays $\Xi^- \rightarrow \Lambda\mu^-\bar{\nu}$ and $\Xi^0 \rightarrow \Lambda\gamma$. The branching ratios of these hitherto unobserved decay modes are $\Gamma(\Xi^- \rightarrow \Lambda\mu^-\bar{\nu})/\Gamma(\Xi^- \rightarrow \Lambda\pi^-) = (3 \pm 3) \times 10^{-4}$ and $\Gamma(\Xi^0 \rightarrow \Lambda\gamma)/\Gamma(\Xi^0 \rightarrow \Lambda\pi^0) = (5 \pm 5) \times 10^{-3}$. One event of the decay $\Xi^- \rightarrow \Lambda e^-\bar{\nu}$ has also been observed. There is no evidence for $\Delta S = 2$ decays; upper limits on these and other rare decay modes are presented. (auth)

**20929** SELF-SIMILAR BEHAVIOR OF MUON PRODUCTION IN THE COSMIC RAYS AT ENERGIES UP TO $10^{13}$ eV. Volkova, L. V.; Zatsepin, G. T. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 157-160(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1066-1069(1974).

A comparison of results on the differential spectrum of cosmic muons with the spectrum calculated on the basis of the model of scale invariance is reported. The positive muon excess and the spectrum of cosmic muons are considered. (JFP)

**20930** $\mu$-e DECAY RATE AT VARIOUS POINTS UNDER GROUND. Alekseev, E. N.; Gurentsov, V. I.; Mikheev, S. P.; Tizengauzen, V. A.; Chudakov, A. E. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 181-184(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1093-1096(1974).

The rate at which muons are stopped in a liquid-scintillator detector was measured in an underground experiment. The ratio of the number of $\mu$-e decays in 100 g/cm$^2$ of liquid scintillator to the number of passing muons was found for depths of 60, 850, and 1150 g/cm$^2$. (auth)

**20931** PASSAGE OF NEUTRINOS THROUGH THE EARTH. Volkova, L. V.; Zatsepin, G. T. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 151-154(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1060-1063(1974).

A calculation is performed showing that it is in principle possible to use the neutrino flux from the decay of $\pi$ and K mesons from accelerators to x-ray the earth in order to extract information about the density distribution within the earth provided that the total cross section for neutrino–nucleon interactions increases linearly with increasing neutrino energy up to very high neutrino energies. This proposed experiment would require a high energy proton beam from an accelerator and means to provide well collimated beams of $\pi$ and K mesons directed into the earth. (JFP)

**20932** HIGH-ENERGY BEHAVIOR OF THE TOTAL CROSS SECTION FOR NEUTRINO–NUCLEON INTERACTIONS. Volkova, L. V.; Zatsepin, G. T. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 155-156(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1064-1065(1974).

Assuming a linear increase on the total cross section for neutrino–nucleon interactions up to neutrino energies of $10^2$ GeV, the value of the cross section can be determined quite accurately from the total flux of muons produced from neutrinos measured in experiments with cosmic neutrinos. A cross section value of $(0.55 \pm 0.15)10^{-13}$cm$^2$/nucleon is found. (JFP)

**20933** NEGATIVE MUON DEPOLARIZATION IN LIQUID HELIUM AND SEVERAL HYDROCARBONS. Buckle, D. C. Williamsburg, VA; Coll. of William and Mary (1974). 128p. University Microfilms Order No. 75-542.

Thesis (Ph. D.).

The asymmetry $a_0$ in the angular distribution of electrons from the decay of polarized negative muons bound in atomic states was measured in several pure substances: C, Mg, O, and He; in $H_2O$; and in several hydrocarbons: toluene, polyethylene, paraffin, and plastic scintillant. The angular distribution was sampled by precessing the muon magnetic moment and observing the time dependence of the decay distribution given by $N(t) = N_0e^{-\lambda t}(1 + a_0\cos\omega t)$. Measurements made at the Larmor precession frequency of the muon spin in C and Mg gave: $a_0^C = -0.048 \pm 0.003$ and $a_0^{Mg} = -0.044 \pm 0.004$. These results are in agreement with theoretical predictions. The result for liquid He was consistent with complete depolarization of the muon spin, in disagreement with theoretical predictions, and was: $a_0^{He} = -0.003 \pm 0.005$. The hydrocarbons and $H_2O$ all yielded values for $a_0$ of approximately $\frac{1}{2}$ the value measured in C. This represents the first observation of reduced residual polarization in these hydrocarbons. The results are compared with theoretical predictions based on the formation of large mesic molecules in the muon atomic capture process. Qualitative agreement is found. Several depolarizing mechanisms for muons in liquid He are discussed and compared to the experimental result. A search was also made for evidence of the formation of a spin coupled system of an atomically bound muon and electron in the total angular momentum $F = S_e + S_\mu = 1$, $m_F = 1$ state. Measurements were made in liquid He, liquid $O_2$, polyethylene, toluene, and plastic scintillant. No asymmetry was seen, for any target, which could be attributed to the formation of this system. (Diss. Abstr. Int., B)

**20934** SOME IMPLICATIONS OF INCLUSIVE ELECTRO- AND NEUTRINO PRODUCTION DATA. Bongardt, K.; Genz, H. (Karlsruhe Univ. (TH) (F.R. Germany). Inst. fuer Theoretische Kernphysik). Z. Phys.; 270: No. 2, 103-111(Oct 1974).

16 refs.

We systematically exploit the reported data on inclusive electron–nucleon, neutrino–nucleon and antineutrino–nucleon interactions in order to test various versions of the quark parton model and to obtain further predictions. (GE)

## Strong (Baryon-induced)

*Refer also to abstracts 21046, 21051, and 21109.*

**20935** (ITEF-92) CHARACTERISTICS OF INELASTIC PROCESSES IN THE REGGIZED SINGLE-PION EXCHANGE MODEL. Boreskov, K. G.; Kajdalov, A. B.; Panomarev, L. A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 34p. (In Russian). INIS.

The results of applying a model of reggized, single-pion exchange to processes of particle formation over a wide region of energies (from 2 GeV to energies ISR) are presented. From a

unified point of view and with the same parameter values a description is given both of exclusive reactions with the formation of one and two π-mesons, and also of inclusive processes. A detailed discussion is given of qualitative predictions and consequences of the model of single-pion exchange for various distributions in exclusive reactions. A good quantitative description of various experimental distributions points to the dominating role of exchange with the π-pole in these reactions. By using the model of single-pion exchange to describe nucleon spectra in the region of fragmentation it was possible to obtain (with the same parameter values as for exclusive reactions) a quantitative description of the dependence of spectra on X and $P_\perp^2$, and also of the change in form of the spectrum with energy. At high energies (starting from a few hundred GeV), a qualitatively new effect occurs; there is a sharp rise in the spectrum at X ~ 1. In the model under consideration this effect is connected with the presence of a three-dimensional peak which can be calculated quantitatively. By means of the model it is also possible to describe quantitatively the multiplicity of charged particles as a function of insufficient mass in the reaction pp→ px. (tr-SJR)

**20936** (JINR-P1-8322) SEARCH FOR NEW HEAVY PARTICLES IN PROTON COLLISIONS WITH NUCLEI AT 70 GeV. Baldin, B. Yu.; Vertogradov, L. S.; Vishnevskii, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 21p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

A search was made for new heavy particles (with a charge of $0.45 \leq |z| < 3$) in the mass range (2.2 to 10)$M_p$. The experiment was performed in a 25 GeV/c beam of negatively charged particles produced by 70-GeV protons on the internal target of the IHEP synchrotron at an angle of 0°. Among $3.75 \cdot 10^{11}$ particles there was observed not a single particle in the investigated mass range except for four $^3\bar{H}$ nuclei. (auth)

**20937** (JINR-P2-8230) FULL CROSS SECTION INCREASE AT HIGH ENERGIES. Solov'ev, L. D.; Shchelkachev, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 62p. (In Russian). Dep. NTIS (US Sales Only) $6.25.

A review is given of latest experimental data on cross sections at high energies; a model for their interpretation is suggested. (auth)

**20938** EXTENSION OF FERMI NATIONAL ACCELERATOR LABORATORY MAGNETIC-MONOPOLE SEARCH TO 400 GeV. Carrigan, R.A. Jr.; Nezrick, F.A.; Strauss, B.P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 10: No. 11, 3867-3869 (1 Dec 1974).

In a search for magnetic monopoles an aluminum target has been exposed to $5.7 \times 10^{16}$ protons of 400 GeV energy at the Fermi National Accelerator Laboratory. The search apparatus employs equipment used previously in a search for monopoles produced by 300-GeV protons, where a cross section of $6 \times 10^{-42}$ cm² was established using an iron dump. For the 400-GeV experiment the equipment was modified to detect magnetic charges down to 1/30 of the Dirac magnetic charge. No magnetic monopoles were found with magnetic charges in the interval from 1/30 to 24 times the Dirac magnetic charge. The upper limit at a 95% confidence level for the cross section per nucleon in aluminum is $5.1 \times 10^{-42}$ cm². (auth)

**20939** INCLUSIVE PRODUCTION OF NEUTRONS IN 300-GeV/c pp INTERACTIONS. Dao, F.T.; Hanft, R.; Lach, J.; Malamud, E.; Nezrick, F. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510); Davidson, V.; Firestone, A.; Lam, D.; Nagy, F.; Peck, C.; Sheng, A.; Poster, R.; Schlein, P.; Slater, W.; Dzierba, A. Phys. Rev. D 10: No. 11, 3588-3593 (1 Dec 1974).

An estimate of the average number of neutrons in 300-GeV/c pp collisions can be made from observed neutron secondary interactions (stars). The data are from a 35000-picture exposure of the Fermi National Accelerator Laboratory 30-in. hydrogen bubble chamber. The average number of neutrons and antineutrons per inelastic collision is found to be $\langle n \rangle + \langle \bar{n} \rangle = 0.8 \pm 0.2$ and their average laboratory energy is ~34 GeV. (auth)

**20940** STUDY OF THE $\bar{p}d \to \bar{p}pn$ AND $\bar{p}n \to \bar{p}n$ REACTIONS AT 5.55 GeV/c. Braun, H.; Brick, D.; Fridman, A.; Gerber, J. P.; Jegham, E.; Juillot, P.; Voltolini, C. (Groupe des Chambres a Bulles a Hydrogene, Centre de Recherches Nucleaires, Strasbourg, France). Phys. Rev. D. 10: No. 11, 3573-3578 (1 Dec 1974).

From a 150000-photograph exposure, we analyzed the $\bar{p}d \to \bar{p}p_sn$ reaction, $p_s$ denoting a proton stopping in the deuterium-filled bubble chamber. Choosing kinematical regions in which the $p_s$ can be recognized as a spectator, we studied the $\bar{p}n \to \bar{p}n$ process. From the observed $\bar{p}n$ diffraction peak, we obtained an exponential slope for the four-momentum-transfer distribution of $b_n = 9.4 \pm 0.8$ $(GeV/c)^{-2}$, the elastic $\bar{p}n$ cross section being estimated as $\sigma_e(\bar{p}n) = 16.5 \pm 2.4$ mb. The present values in conjunction with those obtained at ≃ 1.8 and 3.5 GeV/c show that in this region $b_n$ and $\sigma_e(\bar{p}n)$ decrease with increasing incident momentum. We compared our data with the reactions $np \to np$ at ≃ 5.4 GeV/c and $\bar{p}p \to \bar{p}p$ at 5.7 GeV/c. The $\bar{p}n \to \bar{p}n$ and $np \to np$ differential cross sections exhibit a crossover phenomenon while $\bar{p}p$ and $\bar{p}n$ elastic scatterings show an isospin dependence. We also analyzed the $\bar{p}d \to \bar{p}p_sn$ reaction by means of the Glauber formalism. (auth)

**20941** MULTIPLICITY DISTRIBUTIONS AND MULTIPLICITY SCALING IN p+p→p+MM AT 28.5 GeV/c. Clifford, T.S.; Erwin, A.R.; Ficenec, J.R.; Larson, G.P.; Lazarus, E.; Moy, K.M.; Schreiner, W.N.; Schübelin, P.; Trower, W.P.; Turkot, F. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. Lett. 33: No. 20, 1239-1242 (11 Nov 1974).

The charged particles associated with a fast forward trigger proton of four-momentum transfer t in the reaction p+p→p+MM at 28.5 GeV/c were measured using the Multiparticle Argo Spectrometer System. Charged-particle multiplicity distributions show multiplicity scaling with respect to the missing mass, MM, to ~ 10% within each of two t regions, $0 < |t| < 2$ $(GeV/c)^2$ and $3 < |t| < 5$ $(GeV/c)^2$. The width of the scaling curve shrinks between regions. (auth)

**20942** COMPARISON OF THE CHARACTERISTICS FOR INTERACTIONS OF SINGLE HADRONS WITH LIGHT NUCLEI WITH THOSE FOR THE TOTAL FLUX OF ALL HIGH-ENERGY HADRONS. Grigorov, N. L.; Mitoyan, S. V.; Savel'eva, A. I.; Shestoperov, V. Ya. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 53-55(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 954-957(1974).

Experimental data are reported on the rate at which γ rays (or $\pi^0$ mesons) are produced by single hadrons and by hadrons in groups. The results imply that nucleons and pions produce high energy $\pi^0$ mesons in similar processes. (auth)

**20943** EFFECT OF THE COMPOSITION OF THE HADRON COMPONENT ON THE MULTIPLICITY OF γ-RAYS IN FAMILIES. Budilov, V. K.; Butina, I. I.; Bukhova, N. N.; Baradzei, L. T.; Smorodin, Yu. A.; Shalagina, E. V. (Aviation Technological Inst., Shcherbakov, USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 80-83(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 983-987(1974).

A study is made on the possible use of data on the production of $\pi^0$ mesons found in studies of γ-ray families to compare the characteristics of families due to interactions of nucleons and pions at energies of 10 to 50 TeV. This possibility is related to a change in the composition of the cosmic ray hadron component with atmospheric depth. No difference was found between the limiting fragmentation of nucleons and that of pions. (JFP)

**20944** CROSS SECTIONS FOR INTERACTIONS OF NUCLEONS WITH LIGHT AND HEAVY NUCLEI AT ENERGIES ABOVE 1 TeV. Nam, R. A.; Nikol'skii, S. I.; Pavlyuchenko, V. P.; Chubenko, A. P.; Yakovlev, V. I. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 49-52(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 950-953(1974).

A study of the cross sections as a function of the incident energy is reported for the inelastic interactions of nucleons with air nuclei and of hadrons with lead nuclei above 1 to 2 TeV. The upper limit on the mean free path for interactions of nucleons in air is found using a previous method based on measurements of the flux of hadrons without accompaniment deep in the atmosphere. (JFP)

**20945** STUDY OF HIGH-ENERGY NUCLEAR INTERACTIONS IN THICK TARGETS. Zhdanov, G. B. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 34-37(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 935-938(1974).

Cosmic pp reactions in thick targets are studied for the average number of secondary nuclear-active particles and $\pi^0$ mesons and the distributions of photon and hadron air families. The altitude of the interaction, and the inelasticities and probabilistic evaluation of the primary particle energy are discussed. (JFP)

**20946** DETECTION OF NUCLEAR INTERACTIONS OF HIGH-ENERGY PRIMARY COSMIC RAYS WITH A CONTROLLABLE EMULSION STACK. Brikker, S. I.; Vaisberg, Yu. V.;

Grigorov, N. L.; Grigor'eva, L. B.; Kondrat'eva, M. A.; Mishchenko, L. G.; Nymmik, R. A.; Podgurskaya, A. V.; Poperekova, L. M.; Rapoport, I. D.; Savenko, I. A.; Sobinyakov, V. A.; Sokolov, V. K.; Titenkov, A. F.; Tret'yakova, Ch. A.; Chikova, L. O.; Shestoperov, V. Ya.; Shopenberg, Zh. M. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 30-33(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 930-934(1974).

The interactions of various types of particles (protons, alpha particles, and heavier nuclei) was studied in the energy range of $10^{12}$ to $10^{13}$ eV by means of a photographic emulsion stack combined with an ionization calorimeter. (JFP)

**20947** MEASUREMENT OF THE CROSS SECTION FOR INELASTIC INTERACTIONS OF HADRONS WITH LEAD, ALUMINUM, AND CARBON NUCLEI. Bostandzhyan, N. Kh.; Vardumyan, D. T.; Marikyan, G. A.; Matevosyan, K. A. (Inst. of Physics, Erevan). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 13-15(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 912-914(1974).

Measurements of the cross section for inelastic nuclear interactions above 100 GeV were obtained with an apparatus capable of singling out the high energy particle in a shower and accurately determining its energy and the point at which the inelastic interaction occurs. The cross sections were found for the reactions of cosmic hadrons with lead, aluminium, and graphite nuclei. (JFP)

**20948** ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES IN pN INTERACTIONS AT 200 GeV/c. Antonova, M. G. (Inst. of High-Energy Physics, Alma-Ata, USSR); Boos, E. G.; Loktionov, A. A. Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 24-29(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 923-929(1974).

The general properties of the angular distributions of secondary particles from pp and pn collisions at $p_0 = 200$ GeV/c were studied. The c.m. angular distributions are anisotropic up to extremely high multiplicities. The charged-particle distributions in individual events are nonuniform, especially at low multiplicities ($n \lesssim \langle n \rangle$). At the same values of n there are asymmetric events in the c.m. system. (auth)

**20949** STUDY OF HADRON-INTERACTION PROPERTIES ON THE BASIS OF FLUCTUATIONS OF THE NUCLEAR CASCADES IN DENSE MATERIAL. Anoshin, A. I.; Bashindzhagyan, G. L.; Bel'zer, L. I.; Dem'yanov, A. I.; Murzin, V. S.; Sarycheva, L. I.; Sinev, N. B. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 56-59(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 958-961(1974).

The fluctuations in the electron-nuclear cascades in an ionization calorimeter are analyzed. Deviations from the general behavior which are characteristic of the nuclear-cascade mechanism in dense material are found above 200 GeV. (auth)

**20950** CERTAIN CHARACTERISTICS OF INELASTIC pN AND $\pi$-N INTERACTIONS AT ACCELERATOR ENERGIES. Azimov, S. A.; Bondarenko, A. I.; Gulamov, K. G.; Petrov, V. I.; Riskiev, T. T.; Trofimova, T. P.; Chernova, L. P.; Chernov, G. M. (Physical-Technical Inst., Tashkent). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 5-8(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 902-906(1974).

A comparison of the predictions of certain multiple-production models with several characteristics of pN and $\pi^-$N in the range $p_0 = 20$ to 70 GeV/c is reported. In particular, fluctuations in the multiplicity of particles emitted into different hemispheres in the c.m. system, the distributions of the differences for successive pairs of particles arranged in a variational series, and the azimuthal angular distribution are reported. (JFP)

**20951** EXPERIMENTS WITH POLARIZED BEAMS AND TARGETS. Krisch, A. D. (Univ. of Michigan, Ann Arbor). pp 209-232 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

A lecture is given on possible experiments at the Argonne ZGS and also the spin dependence of strong interactions. The most interesting experiments are considered to be studies of the differences between the various initial spin states in p + p scattering. Acceleration, the total cross section measurement, elastic cross sections with initial spin defined, asymmetry in elastic scattering, elastic cross section with initial and final states defined, inelastic proton-proton scattering, and P and T violations in strong interactions. (JFP)

**20952** VERY HIGH ENERGY PROTON-PROTON SCATTERING. Krisch, A. D. (Univ. of Michigan, Ann Arbor). pp 233-307 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

A lecture is given on experimental techniques at the CERN ISR and on the current data and phenomenology of proton-proton scattering. It is found that there is strong support for a Lorentz contracted geometrical model. (JFP)

**20953** TOPICS IN PARTICLE PHYSICS WITH COLLIDING PROTON BEAMS. Sens, J. C. (CERN, Geneva). pp 105-199 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The topics in particle physics with colliding proton beams cover the basic characteristics of the Cern Intersection Storage Rings, ISR performance and development, one-particle inclusive distributions, summary of low energy missing mass data, the high energy ($s > 100$ GeV$^2$) missing mass experiment, and high energy missing mass data and the triple-Regge limit. (JFP)

## *Strong (Meson-induced)*

**20954** (GIFT-3/74, pp 170-327) VERY HIGH ENERGY HADRON EXPERIMENTS. Diddens, A. N. (CERN, Geneva). 1973.

From 4th GIFT seminar in theoretical physics; Barcelona, Spain (11 Apr 1973).

In strong interactions and high energies.

Recent results of experiments in hadron physics at energies above 100 GeV are reviewed. (auth)

**20955** (JINR-E1-8329) FEW ASPECTS OF PION-NUCLEUS SCATTERING. Nichitiu, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 9p. (CONF-740822-10). Dep. NTIS (US Sales Only) $4.00.

From conference on few body problems in nuclear and particle physics; Quebec, Canada (27 Aug 1974).

Some few new problems of pions on light nuclei scattering are discussed in order to help in planning the future series of experiments (maybe on different meson facilities) taking into account "physical priority". (auth)

**20956** INCLUSIVE $\pi^0$ PRODUCTION IN $\pi^-$p AND $\pi^+$p INTERACTIONS AT 18.5 GeV/c. Biswas, N.N.; Fokitis, E.D.; Bishop, J.M.; Cason, N.M.; Kenney, V.P.; Shephard, W.D. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. D 10: No. 11, 3579-3587 (1 Dec 1974).

We have studied $\pi^0$ production in 18.5-GeV/c $\pi^-$p and $\pi^+$p interactions by using the photons from $\pi^0$ decay which convert to electron pairs in hydrogen. The inclusive $\pi^0$ cross sections for different charged multiplicities have been determined. The dependence of the invariant cross section on the Feynman scaling variable x is presented. The $\pi^0$ production process is compared with $\pi^-$ and $\pi^+$ production for each reaction. We observe that the $\pi^0$ spectrum is similar to the $\pi^+$ spectrum in $\pi^-$p interactions and to the $\pi^-$ spectrum in $\pi^+$p interactions. (auth)

**20957** DIFFERENTIAL CROSS SECTIONS FOR ELASTIC $\pi^+$p SCATTERING BETWEEN 1.2 AND 2.3 GeV/c. Abe, K.; Barnett, B.A.; Goldman, J.H.; Laasanen, A.T.; Steinberg, P.H. (University of Maryland, College Park, Maryland 20742); Marmer, G.J.; Moffett, D.R.; Parker, E.F. Phys. Rev. D 10: No. 11, 3556-3572 (1 Dec 1974).

Differential cross sections for $\pi^+$p elastic scattering in the momentum region 1.2 to 2.3 GeV/c are presented for the center-of-mass angular range $0.9 > \cos\theta > -0.9$. Typically, 50000 events were obtained at each of 16 momenta using magnetostrictive-readout wire spark chambers to detect the particles scattered from a liquid hydrogen target. The results are compared to those of the CERN-71 phase-shift analysis. The well-known dips at $t \simeq -0.7$ (GeV/c)$^2$ and at $u' = -0.2$ (GeV/c)$^2$ are observed. In addition, structure is seen at constant $u' = -1.3$ (GeV/c)$^2$. The results of a pion attenuation study in iron are also presented. (auth)

**20958** PRODUCTION AND DECAY MECHANISM OF THE B MESON AND THE $\omega\pi$ SYSTEM IN $\pi^+$p INTERACTIONS AT 5 GeV/c. Karshon, U.; Mikenberg, G.; Eisenberg, Y.; Pitluck, S.; Ronat,

E.E.; Shapira, A.; Yekutieli, G. (Department of Nuclear Physics, Weizmann Institute of Science, Rehovot, Israel). Phys. Rev. D 10: No. 11, 3608-3616 (1 Dec 1974).

The production and decay properties of the B meson are studied in the reaction $\pi^+p \rightarrow \omega\pi^+p$ at 5 GeV/c, where a cross section of 98 ± 16 μb is found for the final state $pB^+$. The production angular distribution of the $B^+$ shows a forward peak, a possible shoulder at $t' \sim 0.25$ GeV$^2$, and a small backward peak. The most likely spin–parity assignment for the B is found to be $1^+$, and the D–wave fraction in the B decay is ~ 11%. The differential cross section and density matrix elements of the $B^+$ suggest a dominant ω–exchange contribution. The suppression of $A_2$ exchange is also apparent in a study of the reaction $\pi^+p \rightarrow B^0\Delta^{++}$. We obtain for $t'_{p\Delta} < 1$ GeV$^2$ an estimated cross section of 15 ± 12 μb for $B^0\Delta^{++}$ production, which is about 5 times smaller than that of $pB^+$ at the same t' region. The reaction $\pi\pi \rightarrow \pi\omega$, extrapolated to the pion pole, is found to yield near the πω threshold cross sections smaller than previously expected. (auth)

**20959** INTERACTIONS OF $\pi^-$ MESONS ($E_{kin}$ = 60 GeV) WITH Ag AND Br NUCLEI IN THE CASE OF COMPLETE DISINTEGRATION OF THE TARGET NUCLEUS. Gagarin, Yu. F.; Ivanova, N. S.; Myshkin, V. E. (Ioffe Inst. of Physics and Tech., Leningrad). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 84-88(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 988-992(1974).

An attempt to determine certain features of the interaction of pions with heavy nuclei in an emulsion resulting in the complete disintegration of the target nucleus at an incident $\pi^-$ energy of 60 GeV is reported. The angular distributions, average prong numbers, and probabilities for the events are discussed. (JFP)

**20960** EXPERIMENTAL STUDY OF $K^0 \rightarrow \pi^+\pi^-\gamma$ DECAY. Bobisut, F.; Huzita, H.; Mattioli, F.; Puglierin, G. (Univ., Padua). Lett. Nuovo Cim.; 11: No. 15, 646-649(14 Dec 1974).

A study is made of $K^0 \rightarrow \pi^+\pi^-\gamma$ decay in which all the final particles are detected. The upper limit for the branching ratio, the mean life, and the contribution of the direct emission to the studied decay were found. (JFP)

**20961** MEASUREMENT OF THE FORM FACTORS IN THE DECAY $K^+ \rightarrow \pi\mu\nu$. Arnold, C. L. Jr. Ann Arbor, MI; Univ. of Michigan (1974). 241p. University Microfilms Order No. 75-623.

Thesis (Ph. D.).

There were 250,000 pictures of stopping $K^+$ decays studied in the Michigan-ANL 40 inch bubble chamber filled with light freon $C_2F_3Cl$. The data were reduced to a clean sample (≈94%) of 490 $K^+_{\mu 3}$ decays $K^+ \rightarrow \mu^+ + \pi^o + \nu$. This sample was used to measure the slopes of the vector and scalar form factors $\lambda_+$ and $\lambda_0$ by studying the Dalitz plot density. These slopes were found to be: $\lambda_+ = .025 \pm .03$ and $\lambda_0 = -.04 \pm .04$. This result is in good agreement with most other $K_{\mu 3}$ form factor measurements, but does not agree with the current algebra prediction of $\lambda_0 \approx .02$ which follows from the Callen–Treiman point. It also disagrees with a recent high statistics experiment on $K^+_{\mu 3}$ decays. Also the data were analyzed in terms of the form factors $\xi(0)$ and $\lambda_+$ with $\lambda_- = 0$. The values $\xi(0) = -.77 \pm .85$ and $\lambda_+ = .025 \pm .03$ were found in good agreement with several recent $K^+_{\mu 3}$ experiments. (Diss. Abstr. Int., B)

**20962** POLARIZATION IN πp CHARGE EXCHANGE IN THE FORWARD REGION AT 5 GeV/c AND POLARIZATION IN $\pi^\pm p$ ELASTIC SCATTERING IN ALL ANGLES AT THE INTERMEDIATE ENERGIES. Yokosawa, A. (Argonne National Lab., IL). pp 581-610 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

All existing charge-exchange polarization measurements are reviewed for πp interactions–forward interactions at 5 GeV/c, and the different methods used in various experiments are discussed. Also the results of various phase-shift analyses for polarization in π + p elastic scattering at all angles. (JFP)

**20963** IS THERE A LIGHT SCALAR BOSON? Sundaresan, M. K. (Carleton Univ., Ottawa). pp 705-719 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

In view of the recent theoretical interest in the possibility of a low mass scalar meson, an experiment is proposed in which it might be found. (auth)

**20964** ENERGY DEPENDENCE OF $\pi^+p$ BACKWARD ELASTIC SCATTERING FROM 2 TO 6 GeV/c. Lennox, A. J. Notre Dame, IN; Univ. of Notre Dame (1974). 130p. University Microfilms Order No. 75-1857.

Thesis (Ph. D.).

The data obtained in this experiment were used to systematically study the energy dependence of the 180° differential cross section for $\pi^+p$ elastic scattering in the center-of-mass energy region from 2159 to 3490 MeV. Measurements were made for incident pion momenta between 2.0 and 6.0 GeV/c in steps of typically 100 MeV/c. A focussing spectrometer and scintillation counter hodoscopes were used to obtain angular distributions for pions scattering in the angular range 141 to 173° in the laboratory. In general, these angular distributions exhibited an exponential u dependence, where u is the square of the four momentum transfer between the incident pion and the recoil proton. Hence, values for $d\sigma/d\Omega$ at 180° were found by making fits to the form $d\sigma/d\Omega = d\sigma/d\Omega\ (180°)\ \exp[b(u - u_{max})]$, where b is a slope parameter. A resonance model and an interference model were used to perform fits to the energy dependence of $d\sigma/d\Omega$ (180°). Both models led to equally good fits to the data and predicted values for the masses, widths, parities, and the product of spin and elasticity for the Δ(2200), Δ(2420), Δ(2850), and Δ(3230) resonances. On the basis of backward scattering alone it was not possible to determine which model more accurately describes pion-nucleon scattering. However, both models required the existence of a Δ(2200) in order to produce satisfactory fits to the data obtained in this experiment. (Diss. Abstr. Int., B)

**20965** EXPERIMENTAL RESULTS ON THE PRODUCTION AND DECAY MODES OF THE 3101 MeV RESONANCE AT ADONE. Baldini-Cello, R. (CNEN, Rome); Bernardini, M.; Capon, G. Lett. Nuovo Cim.; 11: No. 17, 711-717(28 Dec 1974).

The results of a preliminary analysis of the production and decay modes of the 3101 MeV resonance in the reactions $e^+e^- \rightarrow$ many hadrons, $e^+e^- \rightarrow \mu^+\mu^-$, and $e^+e^- \rightarrow e^+e^-$ is presented. These data refer to a small energy region around the resonance ranging from 3082 to 3112 MeV. A clear peak is observed in all channels at a total cm energy of (3101 ± 2) MeV. The corresponding cross sections were measured and the decay partial widths evaluated. (JFP)

**20966** SINGLE PARTICLE SPECTRA FROM PION–PROTON SCATTERING AT 10 AND 15.5 GeV/c. Delay, M. J. Seattle; Univ. of Washington (1974). 123p. University Microfilms Order No. 75-3968.

Thesis (Ph. D.).

A single-arm spectrometer was used to measure single particle distributions for the inclusive processes π + p → π + anything and π + p → p + anything. Data was taken for all pion charge combinations at incident pion momenta of 10.0 GeV/c and 15.5 GeV/c. The invariant double differential cross sections for the above reactions are presented over the kinematic range $0 \le y_{cm} \le 1.6$, $0.16 \le p_T \le 0.90$ GeV/c for secondary pions, and $-0.4 \le x \le 0.5$, $0.16 \le p_T \le 0.90$ GeV/c for secondary protons. The trends present in the data are discussed, both in terms of dependence on the reaction conditions (such as energy and charge), and in the context of the Mueller-Regge formalism. A comparison is made to data on p + p inclusive reactions. (Diss. Abstr. Int., B)

# Particle Interactions and Properties (Theoretical)

*Refer also to abstract 20903.*

## General

*Refer also to abstracts 20898, 21251, 21253, and 21310.*

**20967** (CERN-74-22, pp 123-179) DEEP INELASTIC PROCESSES. Landshoff, P. V. (Cambridge Univ., Eng.). 30 Oct 1974.

From proceedings of the CERN school of physics; Windermere, UK (16 Jun 1974).

In proceedings of the 1974 CERN school of physics.

The discussion of deep inelastic processes covers deep inelastic electron scattering, the parton and quark models, neutrino processes, the final state, muon-pair production, large transverse momentum in hadron–hadron collisions, and the relation between inclusive and exclusive processes. (JFP)

**20968** (GIFT-3/74, pp 84-169) DUALITY AND THE REGGE APPROACH TO INCLUSIVE REACTIONS. Hong-Mo, C. (Rutherford High Energy Lab., Chilton, Eng.). 1973.

From 4th GIFT seminar in theoretical physics; Barcelona, Spain (11 Apr 1973).

In strong interactions and high energies.

The lectures on duality and the Regge approach to inclusive reactions covers the generalized optical theorem, limiting fragmentation and scaling, the approach to scaling, exoticity and early scaling, the Reggeon–particle amplitude and the triple-Regge expansion, factorization, semi-local duality, semi-local factorization, mass dependence of resonance production cross sections, inclusive reactions as probes to duality, and beyond single-particle distributions. (JFP)

**20969** (GIFT-3/74, pp 328-424) TWO-BODY REACTIONS AT HIGH ENERGIES. Schrempp, B.; Schrempp, F. (CERN, Geneva). 1973.

From 4th GIFT seminar in theoretical physics; Barcelona, Spain (11 Apr 1973).

In strong interactions and high energies.

The guideline for the discussion of inelastic reactions is the question: to which extent may inelastic reactions be understood in terms of "resonance dominance"? Three steps are considered: how much is left of the t channel Regge model today? the link between t and s channel approaches: duality; successful abstractions from the Veneziano formula; how far can one push the s channel approach, i.e., dominance of peripheral resonances? In elastic scattering those ideas are reviewed from which one tries to cope with the recent ISR pp → pp data. (auth)

**20970** (HU-TFT-74-5) LONG RANGE CORRELATIONS IN THE PIONIZATION COMPONENT. Kajantie, K.; Ruuskanen, P. V. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Mar 1974. 16p. INIS.

A simple model for observed pion (in the plateau)-proton (in the fragmentation region) correlations is developed. The model satisfies weak short range order but generates long range correlations by relating the pion multiplicity to the proton elasticity. The magnitude of the normalized pion-proton correlation function is connected to the known properties of mesonic clusters and to the shape of the single-proton spectrum. (auth)

**20971** (IFVE-STF-74-6) ANALYTICITY OF DOUBLE DIFFERENTIAL CROSS SECTION FOR MULTIPARTICLE PRODUCTION PROCESS. Rcheulishvili, G. L.; Samokhin, A. P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1974. 8p. (In Russian). INIS.

For the double differential cross section $d^2\sigma/d\cos\theta d\phi$ and the function $\phi(\cos\theta_1,\phi_1;\cos\theta_2,\phi_2)$; S in the scalar $A^3$ pole approximation of the theory for the process a + b → c + d + f, regions of analyticity according to $\cos\theta$ were obtained for a physical $\phi$. For any energy and $\phi \neq 0, \pi$ these regions are rhombi with vertices and contain fixed neighborhoods of physical points. (tr-auth)

**20972** (JINR–P2-8132) STRUCTURE OF INCOHERENT PARTICLE PRODUCTION CROSS SECTIONS IN NON-DIFFRACTION PROCESSES. Pak, A. S.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

It is shown that for accurate calculation of incoherent particle production cross sections on nuclei in nondiffraction processes at small momentum transfers one needs information not only about the cross sections of corresponding elementary processes but about the structrue of their amplitudes as well. (auth)

**20973** (JINR–P2-8258) HIGH-ENERGY SCATTERING OF COMPOSITE PARTICLES IN THE FUNCTIONAL APPROACH. Nguyen Suan Han; Leonovich, A. A.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 26p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

A method is suggested for constructing scattering amplitudes involving compound particles with the help of the functional integration in the quantum field theory. The obtained expression for the amplitude of the elementary particle scattering by the compound particle (deuteron) in the high energy region is transformed into the Glauber representation of the scattering amplitude on weakly coupled system. (auth)

**20974** (JINR-P2-8338) ASYMPTOTIC METHOD OF SOLVING EQUATIONS FOR PARTICLES WITH SPIN. 1. Goloskokov, S. V.; Kuleshov, S. P.; Mitryushkin, V. K.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

On the basis of the operator method a procedure is developed for finding the asymptotic solutions of the quasipotential equations for particles with spins 0 and ½ and those of the Dirac equation in the limit of high energies and transfer momenta fixed. (auth)

**20975** (JINR-P2-8339) ASYMPTOTIC METHOD OF SOLVING EQUATIONS FOR PARTICLES WITH SPIN. 2. Goloskokov, S. V.; Kuleshov, S. P.; Mitryushkin, V. K.; Smondyrev, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The asymptotic method is developed for finding the solutions of the quasipotential equations for particles with spin ½ in the limit of high energy and transfer momenta fixed. (auth)

**20976** DIRECT COUPLING OF HADRONS TO LEPTONS. Bigi, I.I.Y.; Bjorken, J.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 10: No. 11, 3697-3704 (1 Dec 1974).

We consider the attempt to interpret the recent data on $e^+e^-$ annihilation to hadrons in terms of a direct coupling of electrons to hadrons. Comparable, but not so large, effects are found to be expected in deep–inelastic processes. The possibility of a dependence of $\sigma_{tot}(e^+e^- \rightarrow \text{hadrons})$ upon beam polarization is also discussed, as well as other implications. (auth)

**20977** SCALING IN PION PRODUCTION AT HIGH AND VERY HIGH ENERGIES AND ITS INTERPRETATION. Baradzei, L. T.; Smorodin, Yu. A. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 66-71 (1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 968-973(1974).

Experimental data on the consequences of scaling in cosmic rays and in accelerators are reviewed. The physical causes of scaling are discussed. A model describing the basic phenomena at both high and very high energies is proposed. (auth)

**20978** ANALOGY AND DIFFERENCE BETWEEN THE MULTIPERIPHERAL AND HYDRODYNAMIC MODELS FOR MULTIPLE-PRODUCTION PROCESSES. Rozental, I. L. (Inst. of Cosmic Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 38-42(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 939-943(1974).

Statistical aspects of the basic thrusts for the theory of multiple production–the multiperipheral and hydrodynamic models–are examined and compared. (auth)

**20979** LOCALIZABILITY OF MASSLESS PARTICLES. Angelopoulos, E.; Bayen, F.; Flato, M. (College de France, Paris). Phys. Scr.; 9: No. 3, 173-183(Mar 1974).

Wightman's reformulation of the Wigner-Newton position operators and localizability of a massive particle is generalized so as to include zero mass particles. Different a priori procedures of generalizations are examined: Some negative results based upon a projective induction technique are proved. Some positive results are presented which state that in some sense zero-mass particles are localizable and that their corresponding position operators are candidates for observables. The treatment, which is group theoretical and kinematical in the same sense as that of Wightman, ends with suggestions for further possible developments. (auth)

**20980** PROCEEDINGS OF THE CANADIAN INSTITUTE OF PARTICLE PHYSICS SUMMER SCHOOL, MONTREAL, QUEBEC, AUGUST 28–SEPTEMBER 2, 1972. Henzi, R.; Margolis, B. (eds.). Montreal; McGill University (1973). 733p. (CONF-720868-).

The conference included 19 papers. Separate abstracts were prepared for all papers. (JFP)

*For abstracts of individual papers see: 20904, 20951, 20952, 20962, 20963, 20981–20985, 21021, 21022, 21046–21048, 21058, 21082, 21083, and 21099.*

**20981** MODELS FOR MULTIPLE PRODUCTION: FRAGMENTATION VS MULTIPERIPHERALISM. DeTar, C. E. (Massachusetts Inst. of Tech., Cambridge). pp 77-100 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The fragmentation model is described in some detail; predictions of the multiperipheral models are briefly reviewed; and some methods recently proposed for distinguishing phenomenology are discussed. One- and two-particle inclusive experiments and exclusive experiments are considered. (JFP)

**20982** REGGE PHENOMENOLOGY OF INCLUSIVE REACTIONS. DeTar, C. E. (Massachusetts Inst. of Tech., Cambridge).

pp 101-124 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The lecture on the Regge approach to inclusive reaction phenomenology covers the review of kinematics, predictions for single-particle inclusive reactions, and a prediction for two-particle inclusive reactions. (JFP)

**20983** HIGH ENERGY BEHAVIOR OF CROSS SECTIONS FOR PARTICLES AND ANTIPARTICLES. Martin, A. (CERN, Geneva). pp 369-396 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

Lectures are given on various aspects of the high energy behavior of cross sections for line reversed reactions $A + B \rightarrow C + D$ and $\bar{C} + B \rightarrow \bar{A} + D$, and especially the elastic reactions $A + B \rightarrow A + B$ and $\bar{A} + B \rightarrow \bar{A} + B$. The proof of the Pomeranchuk theorem is discussed in detail and all phenomena which according to the theory must accompany any violation of the Pomeranchuk theorem. Also other asymptotic statements are studied, in particular the equality of elastic cross sections, and it is shown that some results hold under much weaker assumptions than the ordinary Pomeranchuk theorem. Some speculations on the extension of these results to inelastic reactions are also discussed. (JFP)

**20984** COVARIANT PARTON MODEL IN DEEP INELASTIC AND OTHER HIGH ENERGY PHENOMENA. Polkinghorne, J. C. (Cambridge Univ., Eng.). pp 397-432 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

An account is given of a previously developed covariant nonperturbative formulation of parton ideas which when combined with certain dynamical notions described leads to a reasonable quantitative theory capable of explaining the known phenomena. Quark partons, duality, heavy muon pair production, fixed poles in Compton scattering, single-particle electroproduction, and hadronic interactions at high energies are considered. (JFP)

**20985** DIFFRACTIVE EXCITATION MODEL AND INCLUSIVE REACTIONS. Lam, C. S. (McGill Univ., Montreal). pp 613-633 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The diffractive excitation model is reviewed. It is illustrated how single-particle spectra in the fragmentation region can be computed for pp collisions. Other predictions of the model are also discussed briefly. (JFP)

**20986** COULD PION ELECTROPRODUCTION BE A TEST OF CURRENT-CURRENT LIGHT-CONE COMMUTATORS? Burnel, A. (Univ., Liege). Lett. Nuovo Cim.; 11: No. 17, 736(28 Dec 1974).

Two errors are pointed out in a previous treatment of pion electroproduction as a test of current-current light-cone commutators. However, these errors do not affect the conclusion. (JFP)

**20987** PHENOMENOLOGY OF PARTICLES AT HIGH ENERGIES. Proceedings of the Fourteenth Scottish Universities Summer School in Physics, Edinburgh, Scotland, July 29-Aug 18, 1973. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974). 752p.

The conference included 10 papers. Separate abstracts were prepared for all papers. (JFP)

*For abstracts of individual papers see: 20953, 20988-20991, 21029, 21049, 21063, 21064, and 21107.*

**20988** PHENOMENOLOGY OF INCLUSIVE REACTIONS. Roberts, R. G. (Rutherford High Energy Lab., Chilton, Eng.). pp 201-295 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The lectures on the application of Regge ideas to inclusive reactions via the Mueller generalized optical theorem for the study of multiple production also cover duality, the phenomenology of the fragmentation region, central Reggeon phenomenology, triple Regge behavior and application to data, finite mass sum rules, applications of finite-mass sum rules, semi-local duality for Reggeon-particle scattering, diffraction, and correlations. (JFP)

**20989** MULTIHADRON PRODUCTION AT HIGH ENERGIES: PHENOMENOLOGY AND THEORY. Harari, H. (Weizmann Inst. of Science, Rehovot, Israel). pp 297-397 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

In these lectures on multihadron high energy production phenomenology and theory restriction is made to small transverse momentum, large multiplicity, and final states. Lessons from two-particle final states and their generalization, a two-component view of multihadron production, the diffractive component and its possible relation to the rising cross section, statistical mechanics of the Feynman gas, the unit intercept of the Pomeron, and the truly asymptotic pomeron for absorptive effects in multihadron production are covered. (JFP)

**20990** AMPLITUDE ANALYSES IN THREE BODY FINAL STATES. Cashmore, R. J. (Stanford Univ., CA). pp 611-700 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The review of amplitude analyses in three-body final-states covers the methods of analyzing three-body final states, the calculation of transition amplitudes to three-particle states, and results obtained from formation experiment and from production reactions. (JFP)

**20991** SOME EXPERIMENTS ON MULTIPLE PRODUCTION. Wilson, K. G. (Cornell Univ., Ithaca, NY). pp 701-725 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

An experimental program for studying multiple production is proposed for the study of secondary particle spectra to test scaling hypotheses derived from the multiperipheral model. The proposed experiments are on partial cross sections as a function of energy, beam survey from a hydrogen target, factorization in the single-particle spectrum, the $dk_2/k_2$ law, search for double pomeron exchange, correlation length experiment, and a test of factorization in multiperipheral processes. (JFP)

**20992** ASPECTS OF EXCHANGE PROCESSES. Lam, K. C. Eugene, OR; Univ. of Oregon (1974). 79p. University Microfilms Order No. 75-3898.

Thesis (Ph. D.).

A discussion of the spin structure of exchange processes covers the partial success of various existing theorems and the capability of the Regge pole theory in reproducing some regular features in particle scattering differential cross sections and polarization parameters motivating the present work in which one tries to connect the basic properties of single particle exchange and infinite particle exchange. Rarita-Schwinger formalism of spin function is used in the calculation of a Feynman diagram. A theorem is proved relating the spin structure of the invariant amplitudes for the exchange of particles of different intrinsic spins. Then with the help of the nondynamical formalism of particle reactions the usefulness and the importance of the theorem are illustrated by two examples. A discussion of the peripheral model with strong cut-off in orbital angular momentum space covers a simple Born amplitude for a Feynman diagram is quite successful in explaining many experimental results at low energies, but it fails quite miserably at intermediate and high energies, especially when high spin particles are involved. Most models are equivalent to different ways of modifying various partial waves in the Born term. It is argued that it is better to carry out the tempering in the orbital angular momentum space than in the total angular momentum space. A model is proposed, and calculation is done by data fitting to find the two energy dependent cut-off parameters for the pion-nucleon charge exchange reaction. The resulting theoretical curves fit the pion-nucleon reaction very well, but when the parameters are applied to the following reactions: $\pi^+p \rightarrow \pi^0N^{++}$, $\pi^+p \rightarrow \kappa^+\Sigma^+$, $\pi^+p \rightarrow \rho^+p$, and $\pi^-p \rightarrow \rho^0n$ the results are not so good. Computation indicates that each reaction should have its own cut-off parameters. (Diss. Abstr. Int., B)

**20993** TRANSFORMATIONS BETWEEN CURRENT AND CONSTITUENT QUARKS IN THE FREE QUARK MODEL. Rabl, V. B. Columbus, OH; Ohio State Univ. (1974). 67p. University Microfilms Order No. 75-3173.

Thesis (Ph. D.).

Transformations which convert current algebras into Hamiltonian symmetries are studied in the free quark model with particular attention to their Hilbert space properties. Eigenstates of the current charges are obtained in the process. Distributions, induced by these improper unitary transformations, of current quarks in a constituent quark are calculated and discussed. A parton model interpretation of the distributions is shown not to be possible within this framework. (Diss. Abstr. Int., B)

**20994** ON THE REPRESENTATIONS OF THE PARTITION FUNCTION OF A SYSTEM OF INTERACTING BOSONS AS INTEGRALS OVER GAUSSIAN RANDOM FIELDS. Wiegel, F. W.; Hijmans, J. Kon. Ned. Akad. Wetensch., Proc., Ser. B; 77: No. 3, 177-197(1974).

The relations between various functional integral representations of the partition function of a system of interacting bosons are investigated. By starting from Feynman's path-integral representation and expressing the partition function as a sum of contributions from sets of virtual trajectories of the particles, Siegert's representation is derived from the grand partition by interpreting the pair potential as the covariance of a Gaussian random field, $\phi(r)$. The expression is recast into a more convenient form by making the functional dependence on the field $\phi(r)$ explicit and introducing a grand-canonical free propagator defined in a 4-dimensional space $(r,\tau)$, where $\tau$ represents a virtual reciprocal temperature. A parametrization of the grand canonical free propagator is introduced by identifying it with the covariance of a second Gaussian random field $\phi(r,\tau)$, and "undoing" the first parametrization of the interaction potential, by carrying out the $\phi$-average explicitly. In this way the Bell–Hirota representation is derived, which bears a formal resemblance to the usual second-quantized form of the partition function except that all operators have been replaced by 4-dimensional classical fields. (INIS)

**20995** ACCELERATED-CONVERGENCE TECHNIQUE AND ANALYTICITY. Choudhary, A. R. (Univ., Louvain, Belgium). Lett. Nuovo Cim.; 12: No. 2, 33-36(11 Jan 1975).

The use of conformal mappings in elementary particle physics is discussed in view of its implications for the analytic properties of the amplitude. It is noted that this mapping can be used to describe energy-dependent representations for $\pi$N elastic scattering amplitudes in the forward or backward directions. (JFP)

**20996** SPIN ALGEBRAS OF PARTICULAR INTEREST. Beckers, J.; Pirotte, C. (Univ., Liege). Lett. Nuovo Cim.; 12: No. 2, 49-52(11 Jan 1975).

A general discussion was recently given of spin algebras in the case of nonzero-rest-mass particles corresponding to the study of the irreducible unitary representations of the Poincare group. It is shown how very simple manipulations on the linear combinations of the given type between certain operators lead to new interesting algebras. (JFP)

**20997** ALGEBRAIC METHODS IN HIGH-ENERGY SCATTERING. Reddy, V. T. N. Austin, TX; Univ. of Texas (1974). 84p. University Microfilms Order No. 75-4444.

Thesis (Ph. D.).

Regularities in physical phenomena often find expression in terms of Lie algebras. The $(U(6) \times U(6))_S$ algebra of vertex strengths (AVS) is an algebraic analog of the additive quark model for high energy scattering, with both similarities and differences. The algebra was analyzed and the consequences of AVS for forward differential cross sections and spin density matrices in two body high energy scattering worked out. A critical comparison was made with the quark model and experimental data to determine which is closer to observation. A connection was shown between The Cabibbo-Horwitz-Ne'eman algebra (CHN), which is a subalgebra of AVS, and The Fritzsch–Gell–Mann algebra of currents and bilocals on the light cone. Such a connection serves two purposes: first, it is a step in the direction of the unification of the two phenomenological expressions of the basic quark like structure of the interactions of hadrons and second, it uncovers a source of corrections to CHN and the quark model. These corrections depend on the representation structure of bilocal charges on the null plane and will be a subject of future inquiry. Comments are made on the nature of these corrections. (Diss. Abstr. Int., B)

## *Electromagnetic*

*Refer also to abstract 21324.*

**20998** (AD-784244) EFFECT OF A STRONG RADIATION FIELD ON AN ELECTRON MOVING IN A PLANE ELECTROMAGNETIC WAVE. Ternov, I. M.; Khalilov, V. R.; Zhuravlev, A. F.; Chizhov, G. A. Translated from Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 7-16(1973). 14p. (FSTC-HT-23-1840-73). NTIS $4.00.

The effect of an external radiation field with arbitrary spectral composition on an electron which is moving in the field of a monochromatic plane electromagnetic wave (first wave) is considered. The change in the average energy of a relativistic electron in its interaction with a radiation field is studied. Conditions are found for which the acceleration of an electron because of an external field balances the loss of energy of the electron in self-radiation. (auth)

**20999** (DESY-74/55) NEW HADRONIC DEGREE OF FREEDOM, $e^+e^-$ ANNIHILATION AND DEEP INELASTIC SCATTERING. Schildknecht, D.; Steiner, F. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Nov 1974. 12p. Dep. NTIS $4.00.

Conjecturing "new duality" for $e^+e^-$ into hadrons of a new degree of freedom, it is shown that presently known information on the particles at 3.105 and 3.7 GeV is compatible with $R \cong 4$. Scaling violations expected in deep inelastic scattering are related to the properties of $\psi(3105)$. (auth)

**21000** (JINR-P1-8297) CALCULATION OF THE CORRECTIONS TO DIFFERENTIAL CROSS SECTION IN THE 50 GeV $\pi-e$ SCATTERING EXPERIMENT. Adylov, G. T.; Vodop'yanov, A. S.; Gaevski, V.; Nigmanov, T. S.; Tsyganov, E. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 17p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The description of the calculation of the corrections to the differential cross section for $\pi-e$ scattering at 50 GeV is presented. (auth)

**21001** (LBL-3612) LEPTON QUARKS. Godfrey, G. L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1974. Contract W-7405-eng-48. 9p. Dep. NTIS $4.00.

A scheme is presented whereby $e^-$, $\nu$, $\mu^-$ form a U(3) triplet. In a natural way a fourth weak quark $I$ will be introduced to form an SU(4) quartet. The $\psi(3105)$, $\psi(3695)$, and apparent channel opening at about $E_{cm} = 4$ GeV observed in the recent SPEAR data is then explained. The fourth weak quark $I$ has I = 0 and Q = +2. (auth)

**21002** (LNF-74/59(P)) DEEP INELASTIC PROCESSES FROM A NON-ORTHODOX POINT OF VIEW. Greco, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 5 Nov 1974. 39p. Dep. NTIS (US Sales Only) $5.00.

Lectures are given on deep inelastic processes from the unconventional viewpoint that no elementary constituents are invoked but rather scaling properties are accommodated in a fairly natural way by imposing on the current-induced processes the regularities observed in purely hadronic reactions. The starting point is the attempt to unify the electromagnetic properties of hadrons both in the small $q^2(q^2 \simeq 0)$ region and the large $q^2(q^2$ both positive and negative) deep inelastic region, where point-like behavior seems to be suggested. The central idea borrowed from the dual models is that the photon is coupled to a Veneziano-like spectrum of vector states whose properties can be deduced by linking consistently various processes corresponding to different $q^2$ regions. The processes $e^+e^-$ annihilation into hadrons, photo- and electroproduction, deep inelastic neutrino reactions, and inclusive processes $pp \to \mu^+\mu^-$ + anything and $\gamma\,(q^2) + p \to$ hadron + anything in the photon fragmentation region are discussed. (JFP)

**21003** (ORO-4856-1) ELECTROMAGNETIC INTERACTIONS OF NUCLEONS. Technical Report No. 75-050. Banerjee, M. K. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jan 1975. 54p. Dep. NTIS $5.75.

The one photon exchange potential and the potential due to the combined exchange of a photon and a pion were calculated using the Blankenbecler–Sugar theory. It is found that the relativistic correction terms in the one photon exchange potential are different from the ones used in previous work. The correct treatment of these terms is discussed. Using these two potentials as the source of charge asymmetry and assuming that the Reid soft core B potential plus the point Coulomb force explain the p–p scattering data one obtains $a_{nn} = -16.06$ fm which compares favorably with the present uncertain experimental value of $-16.4 \pm 0.9$ fm. These two mechanisms plus the charge dependence of pion mass produce $^1S\ a_{np} = -20.46$ fm. The experimental value is $-23.715$ fm. The relativistic term $3e^2/4M^2\ (\vec{p}^2V_1 + V_1\vec{p}^2)$, where $V_1$ is the Coulomb potential with the proton charge distribution folded in, which appears in the one photon exchange potential, produces a 3% correction to the Coulomb energy difference in the $^{41}Se-^{41}Ca$ case which is about a third of the Nolen-Schiffer anomaly. (auth)

**21004** RELATION AMONG STRUCTURE FUNCTIONS FOR MASSIVE CURRENTS. Bander, M.; Rangachari, M. (Department of Physics, University of California, Irvine, Irvine, California 92664). Phys. Rev. D 10: No. 11, 3887-3888 (1 Dec 1974).

A relation among structure functions for processes involving massive photons (deep–inelastic electron scattering, $e^+ + e^-$ annihilation into hadrons and massive lepton pair production) is presented. This relation is valid in a variety of models. A rough comparison with experimental

data shows this relation to be grossly violated. Some speculations on this violation are presented. (auth)

**21005** COMMENT ON VECTOR-MESON DOMINANCE AND THE $\gamma \to 3\pi$ VERTEX IN THE LOW-ENERGY LIMIT. Rudaz, S. (Institute for Theoretical Physics, State University of New York, Stony Brook, Long Island, New York 11794 and Physics Department, McGill University, Montréal, Québec, Canada). Phys. Rev. D 10: No. 11, 3857-3861 (1 Dec 1974).

It is found that a simple derivation of a relation between the $\gamma \to 3\pi$ and $\pi^0 \to 2\gamma$ vertices, previously obtained from current algebra and the partial conservation of axial-vector current anomaly, can be given on the basis of a pole model together with vector-meson dominance if we require consistency between a $\rho$-pole description of $\pi\pi$ scattering in the framework of a Yang-Mills theory and a theorem of Weinberg for the same process in the two-soft-pion limit. (auth)

**21006** FIXED POLES OF PHOTONIC AMPLITUDES INVOLVING COMPOSITENESS. Hite, G.E. (Fachbereich Physik, Universität Trier-Kaiserslautern, 675 Kaiserslautern, Germany); Müller-Kirsten, H.J.W. Phys. Rev. D 10: No. 11, 3761-3768 (1 Dec 1974).

The existence and significance of the right-signature $J = 0$ fixed pole in vector scattering such as photoproduction and Compton scattering off protons and pions is investigated in the context of gauge-invariant models involving compositeness which have been developed in a previous paper. It is shown that the existence of such a fixed pole depends on the elementarity of the photon and not on the compositeness of the pion or proton target or on the assumption that the charged constituents of the target have no structure. Assuming the $\rho$ meson lies on a Regge trajectory, we show that within the context of these models a $J = 0$ fixed pole does not arise in $\rho$-meson photoproduction. (auth)

**21007** $Z^0$ EFFECT IN LEPTON-PAIR PHOTOPRODUCTION. Cahalan, R.F. (Physics Department, Syracuse University, Syracuse, New York 13210); Mikaelian, K.O. Phys. Rev. D 10: No. 11, 3769-3779 (1 Dec 1974).

We study the modifications of lepton-pair photoproduction due to the spin-one $Z^0$ appearing in gauge theories of the weak interactions. It gives rise to a resonance in the invariant mass of the pair. To obtain exact results we consider neutral currents involving only the known leptons, and still we find an effect significantly above the electromagnetic Bethe-Heitler background. Aside from the resonance, a unique parity-violating signal occurs in the form of an azimuthal asymmetry. For a typical $Z^0$ mass of 10 GeV and beam energy of 400 GeV, it is on the order of 5%. Our results are easily adapted to any model of leptons and would probably be much increased by the hadronic part of the neutral current. The leptonic mechanism involves the VVA triangle, for which a previous result is extended to any energy, momentum transfer, and lepton mass. (auth)

**21008** EFFECTS OF FINAL-STATE INTERACTION IN LEPTON-PAIR PRODUCTION IN PROTON-PROTON COLLISIONS, AND IN THE MASSIVE QUARK MODEL FOR ELECTROPRODUCTION. Kingsley, R.L. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 10: No. 11, 3666-3672 (1 Dec 1974).

We point out that analysis of a particular structure function for massive muon-pair production in proton-proton collisions may be capable of signaling the diffractive corrections which are expected, in the parton model, to be present in addition to the "bare" Drell-Yan term. A similar analysis of single-particle semi-inclusive electroproduction in the massive quark model suggests that the azimuthal angle dependence should be suppressed at most by logarithms of $q^2$, at variance with the behavior expected in the parton model. This investigation reveals the importance of a particular assumption which is necessary in the derivation of the parton-model result. (auth)

**21009** PROBING PARTON DISTRIBUTION FUNCTIONS IN MASSIVE LEPTON-PAIR PRODUCTION. Chu, G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Gunion, J.F. Phys. Rev. D 10: No. 11, 3672-3684 (1 Dec 1974).

We analyze massive $\mu$-pair production in hadron-hadron collisions using the parton model, and obtain expressions for general differential cross sections, $d\sigma/d^4Q$, in the $\mu$-pair momentum. We indicate ways in which the parton distributions in both longitudinal and transverse momenta may be probed in detail. Finally, we apply our results to the data by using parton distribution functions with threshold behavior ($\omega = 1/x \to 1$) implied by the interchange model for large-angle scattering. Our results are (1) the calculated cross section is only five percent of the observed cross section at Brookhaven energies; (2) inclusion of nonpointlike structure for the partons which enables one to explain the $e^+-e^-$ annihilation data results in only a marginal improvement in the normalization, but (perhaps accidentally) allows one to approximately describe the shape of the invariant mass distribution $d\sigma/dQ^2$. (auth)

**21010** STRENGTH OF ApK COUPLING BY EXTRAPOLATION OF KAON PHOTOPRODUCTION CROSS SECTION. Deo, B.B.; Bisoi, A.K. (Department of Physics, Utkal University, Bhubaneswar-4, Orissa, India). Phys. Rev. D 10: No. 11, 3691-3696 (1 Dec 1974).

The ApK coupling constant has been determined by extrapolation from low-energy photoproduction differential scattering data. Data at the three energies, 1.06, 1.16, and 1.2 GeV, were analyzed by the optimal-polynomial-extrapolation method proposed by Cutkosky and Deo. In contrast to the very low value of this coupling constant obtained from multipole and other analyses, we find that $g^2_{ApK}/4\pi = 12.4_{-0.5}{}^{+0.8}$, in good agreement with extrapolation results from the $K^+p$ elastic scattering data. (auth)

**21011** $SU(6)_W$ ANALYSIS OF THE ELECTROPRODUCTION OF PSEUDOSCALAR MESONS IN THE SECOND RESONANCE REGION. Avilez, C. (Escuela Superior de Física y Matemáticas, Instituto Politecnico Nacional de México 14, D.F.); Cocho, G. Phys. Rev. D 10: No. 11, 3638-3644 (1 Dec 1974).

Recent data on the photoproduction and electroproduction of $\pi$ and $\mu$ mesons in the second resonance region are analyzed assuming that the electromagnetic current transforms on the W spin as a mixture of $W = 0$ and $W = 1$, $W_z = 0, \pm 1$. The data favor the presence of a term transforming as $W = 1$, $W_z = 0$, with the $W = 0$ and $W = 1$, $W_z = 0$ matrix elements showing similar $q^2$ dependence, $q^2$ being the square of the mass of the virtual photon. The ratio between the two helicity cross sections $\sigma_{1/2}/\sigma_{3/2}$ is found to be small for $0 < -q^2 < 1.5$ GeV$^2$. (auth)

**21012** DEEP-INELASTIC ELECTROPRODUCTION AND KOBA-NIELSEN-OLESEN SCALING. Eilam, G.; Gell, Y. (Physics Department, McGill University, Montreal, Quebec, Canada). Phys. Rev. D 10: No. 11, 3634-3637 (1 Dec 1974).

The multiplicity distribution measured in hadron-hadron collisions is related to the parton distribution measured in deep-inelastic leptoproduction. This relation results from a parton model in which bunches of particles are created through parton-parton collisions. The data on $pp \to n$ charged particles are compared with the model, and some further predictions are discussed. (auth)

**21013** ELECTRON SPATIAL DISTRIBUTION NEAR THE AXIS OF A SHOWER DUE TO A $\gamma$ BEAM IN A STRATIFIED MEDIUM. Astaf'ev, V. A.; Guzhavin, V. V.; Ivanenko, I. P.; Roganova, T. M.; Fedorova, G. F. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 135-141(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1043-1049(1974).

The electron spatial distribution near the axis of a shower due to a $\gamma$ beam in a stratified medium is calculated for detectors with nuclear emulsions or x-ray film. The case is treated in which the gap between two layers of a dense absorber reaches large values; in this case the spatial distribution of the shower particles incident on the second layer is governed primarily by the angular distribution of electrons and photons emerging from the first layer. The p - C and N - Ag collisions are considered for the same primary energy of the proton and the N nucleus (3160 GeV). Also the electromagnetic cascades produced by such gamma rays in an emulsion chamber are discussed. (JFP)

**21014** FLUCTUATIONS IN THE SPATIAL DISTRIBUTION OF ELECTRONS IN EXTENSIVE AIR SHOWERS IN THE ENERGY RANGE $10^{17}-10^{19}$ eV. Dedenko, L. G.; Dymova, I. A. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 126-129(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1033-1036(1974).

Calculations of the fluctuations in the spatial distribution of electrons were carried out for vertical extensive air showers at $10^{17}$ to $10^{19}$ eV at sea level. The development of nuclear cascades is incorporated more rigorously than in previous work. It is noted that these results can be used to calculate the distribution of showers with respect to the number of particles and the primary-particle spectrum with an account of the method used to select showers. (JFP)

**21015** ANGULAR DISTRIBUTION OF PARTICLES IN A CASCADE SHOWER WITH AN ACCOUNT OF IONIZATION LOSS. Guzhavin, V. V.; Ivanenko, I. P.; Kirillov, A. A.; Paskhalov, Yu. I. (Inst. of Radio Engineering, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 130-134(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1037-1042(1974).

The electron angular distribution is analyzed at various stages in the development of a cascade, taking ionization loss into ac-

count. As an example, the electron angular distributions are calculated for $E > 0$ at depths of $t = 10$ and 15 for $E_0 = 10^4\beta$ and for a depth of $t = 10$ for $E_0 = 10^6\beta$. (JFP)

**21016** CALCULATED CHARACTERISTICS OF THE NUCLEAR AND MUON COMPONENTS OF EXTENSIVE AIR SHOWERS AT 690 g/cm². Popova, L. (Inst. of Nuclear Physics and Nuclear Energetics, Sofia). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 122-125(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1029-1032(1974).

A Monte Carlo calculation was carried out for the muon spatial distribution and the hadron energy spectrum on the basis of a two-fireball model with $n_s \sim E^{\frac{1}{4}}$. The muon distribution is predicted to be steeper than that measured by the Tyan-Shan apparatus, probably because of the average transverse momentum selected, 0.4 GeV/c. The correlation between $p_\parallel$ and $p_\perp$ and a higher muon-production level must be taken into account. The index of the integral hadron spectrum is 0.91 over the range 100 to 400 GeV and 1.85 above 1 TeV. (auth)

**21017** EFFECT OF NUCLEAR FRAGMENTATION ON THE CHARACTERISTICS OF EXTENSIVE AIR SHOWERS. Kalmykov, N. N.; Kulikov, G. V. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 118-121(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1024-1028(1974).

The consequences of fragmentation of the primary nuclei for the electron and muon EAS components are analyzed. Disintegration schemes were used for a Monte Carlo calculation of extensive air showers resulting from various primary particles having energies of $10^{15}$ to $10^{17}$ eV. The development of cascades from nucleons is analyzed on the basis: the traditional model with a multiplicity $n \sim E_0^{\frac{1}{4}}$ and the high multiplicity model with a multiplicity $n \sim E_0^{\frac{1}{4}}$. (JFP)

**21018** PHOTOMETRIC DENSITIES OF THE SPOTS DUE TO NUCLEAR-ELECTRON CASCADES IN THE HADRON UNITS OF X-RAY EMULSION CHAMBERS. Azimov, Z. A.; Vrotnyak, A.; Mikhalyak, V.; Smorodin, Yu. A.; Smorodin, A.; Tomashevskii, A. (Univ., Lodz, Poland). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 72-75(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 974-977(1974).

Various properties of nuclear-electron cascades were calculated on the basis of the photometric densities of spots in the x-ray film of x-ray emulsion chambers. The integral photometric densities of spots due to electron-nuclear cascades at specified energies were found. (JFP)

**21019** TWO-COMPONENT THEORY OF THE PHOTON. Schlereth, H. (Techniche Hochschule, Aachen). Lett. Nuovo Cim.; 11: No. 15, 641-645(14 Dec 1974).

The possible effects of a surface S forming the boundary between $G_1$ and $G_2$ which is a region not belonging to $G_1$ are treated in a previous two-component theory for the photon based on the model Lagrangian. (JFP)

**21020** ELECTRON FIELD PAIR PRODUCTION BY PHOTONS AT 2.614 MeV. Augerat, J.; Avan, M.; Ballet, M.; Jousset, J.; Parizet, M. J.; Roche, G. (Univ., Clermont, France). Lett. Nuovo Cim.; 11: No. 16, 685-690(21 Dec 1974).

For the study of the pair production process by gamma rays in the electron field near the threshold at 2.614 MeV, a definitive method is given to analyze the rough experimental results, and the first available data are compared to the theory. The cross sections and energy and angular distributions are considered. (JFP)

**21021** GENERALIZED VECTOR DOMINANCE. Sakurai, J. J. (Univ. of California, Los Angeles). pp 435-474 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

A unified understanding of spacelike processes initiated by ep and μp collisions and timelike processes initiated by $e^+e^-$ collisions is given, using generalized vector dominance, which implies attempts to understand spacelike photon processes like electron-hadron scattering and electroproduction or muoproduction using knowledge of the hadronic vector states that can be formed in $e^+e^-$ collisions. Colliding beam experiments, the pion radius, the proton form factor, and inelastic electron-nucleon scattering are covered. (JFP)

**21022** PHOTON-HADRON INTERACTIONS AT HIGH ENERGIES. Sakurai, J. J. (Univ. of California, Los Angeles). pp 475-513 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The review of photon-hadron interactions at high energies includes discussions of similarities and differences between photon-induced reactions and meson-induced reactions. It is illustrated how the ideas and techniques found to be useful in hadron physics can be successfully applied to photon-induced reactions. Special attention is given to those yet-to-be verified predictions which emphasize possible differences between photon- and hadron-induced reactions. Inclusive interactions, pseudoscalar meson photoproduction, vector meson and total photoproduction, and the fixed pole in Compton scattering. (JFP)

**21023** PROBLEMS CONCERNING RADIATIVE CORRECTIONS IN GAUGE THEORIES OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Marciano, W. J. New York; New York Univ. (1974). 77p. University Microfilms Order No. 74-30,014.

Thesis (Ph. D.).

The research presented focuses on the gauge theories of weak and electromagnetic interactions. It is specifically concerned with an examination of radiative corrections in these theories. The results are divided into three topics which are briefly described. The first topic concerns a study of the deviations from electron-muon universality in the leptonic decays of the intermediate bosons. Such deviations may be induced by higher order perturbation corrections. Some general theorems are derived for the second order weak and electromagnetic corrections which are valid for all renormalized gauge theories which incorporate electron-muon universality as a natural zeroth order relation. The connection of the results with the theorem on the cancellation of mass divergences is also briefly discussed. The second topic investigated involves a detailed calculation of the leading finite corrections to the lowest order natural relation, $g_W^2 = e^2/(1-R)$, between renormalized coupling constants in the Weinberg-Salam SU(2) × U(1) gauge model. The results of this computation enable one to express decay rates, previously obtained in terms of the weak coupling constant, in terms of the physical electron charge and the various physical masses of this model. The calculations were carried out using two different gauge invariant dimensional regularization schemes. A brief outline and comparison of the technical aspects of these methods is included. Finally, the results of an investigation into the cancellation of divergences in a simple hadronic extension of the SU(2) × U(1) Weinberg-Salam gauge model are presented which includes the Cabibbo angle and incorporates the G.I.M. mechanism to eliminate $\Delta S = 1$ neutral currents. A simple technique for studying this problem is developed and various calculations which demonstrate the consistency of this method are presented. (Diss. Abstr. Int., B)

**21024** CONTRIBUTION OF THE RHO-EXCHANGE DIAGRAM INTO THE ETA-MESON PHOTOPRODUCTION ON PROTONS. Radutskij, G. M.; Serdyutskij, V. A.; Tabechenko, A. N. (Tomsk Politechnical Inst., USSR). Izv. Tomsk. Politekh. Inst.; 206: 47-49(1973). (In Russian).

The calculation of the angular distribution of η mesons produced by γ quanta at 1 and 1.5 GeV on protons was reported; proton structure was taken into account. The contribution of the ρ exchange diagram to the photoproduction cross section was calculated by using the ρ photon analogy model. The results obtained were not inconsistent with available experimental data. (tr-INIS)

**21025** INCLUSIVE ELECTROPRODUCTION OF TWO HADRONS. Pal, B. K. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 11: No. 17, 733-735(28 Dec 1974).

The process $\gamma_\nu + p \rightarrow p_1 + p_2 + X$ is studied in three different regions using an extension of the original Mueller analysis from hadron reactions to inclusive electroproduction. It is shown that in the leading-pomeron trajectory the invariant cross section is independent of $\nu$. It is also observed that there is no correlation between the fragmentation of the current and that of the target. This is consistent with the parton model. (JFP)

**21026** MULTIPOLE REPRESENTATION OF THE INTERACTION HAMILTONIAN OF A PARTICLE WITH A STATIC OR DYNAMIC FIELD. Marcilhacy, G. (Institut Henri Poincare, Paris). Lett. Nuovo Cim.; 11: No. 17, 723-727(28 Dec 1974).

The Hamiltonian of a charged particle in an external electromagnetic field is written to take into account the multipolar representation of the potentials derived from the field variables only. Three cases are characterized: the static case, the case of the electromagnetic waves, and the general case. (JFP)

**21027** A MODIFIED BORN TERM MODEL FOR $\pi^+\Delta$ ELECTROPRODUCTION. Bartl, A.; Wittmann, K. (Mainz Univ. (F.R. Germany). Inst. fuer Physik). Z. Phys.; 269: No. 4, 399-406 (Sep 1974).

4 figs.; 1 tab.; 18 refs.

An electric Born type model is used to describe $\pi^+\Delta$ electroproduction at high energies. The electric pion form factor is taken from VDM; the contact term form factor and the $\Delta$ form factor are set equal to the proton form factor (or equal to zero) which is left as an arbitrary parameter, and is determined by a fit of the model to the recent $\pi^+\Delta^0$ and $\pi^-\Delta^{2+}$ electroproduction data. (auth)

**21028** EXACT SOLUTION TO SOME NONLINEAR PROBLEMS OF MATHEMATICAL PHYSICS AND TO SOME NONLINEAR DIFFERENTIAL EQUATIONS. Reid, J. L. Clemson, SC; Clemson Univ. (1974). 137p. University Microfilms Order No. 75-4173.

Thesis (Ph. D.).

Exact solutions were found to three widely distinct nonlinear problems of mathematical physics. Unity, however, was provided by the mathematical method of solving the nonlinear ordinary differential equations which describe the physical problems. These nonlinear equations were solved in terms of the solution, or solutions, of a related differential equation called the base equation. The latter may be linear or nonlinear. The first problem concerned the nonrelativistic motion of a charged particle in a time-dependent axial magnetic field. From the base equation point of view, the second problem treated certain annealing equations associated with vacancy-interstitial annihilation in a solid. The third problem involved the distribution of space charge for thermionic emission of electrons, under conditions of thermal equilibrium, from the surfaces of "double diodes" of planar, cylindrical, and spherical configurations and from single electrodes of similar shapes. Explicit solutions were presented for some nonlinear ordinary differential equations of the second order for which the base equation method is applicable. Generalizations to nonlinear partial differential equations, and a quantum field theory application thereof, were noted. (Diss. Abstr. Int., B)

**21029** ALGEBRAIC PROPERTIES OF ELECTROMAGNETIC AND WEAK CURRENTS AND THEIR REPRESENTATION ON HADRON STATES. Gilman, F. J. (Stanford Univ., CA). pp 553-610 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The relation between the two uses of quarks, that of describing hadron spectroscopy and that of constructing algebras from current components, is considered. This relation is formulated in terms of a transformation between basis states of the algebra of currents, going from a set of irreducible representations to those complicated mixtures of representations characteristic of the physical hadron under the action of the algebra of vector and axial-vector charges. The theoretical framework allows treatment, as a first step, of vector and axial-vector transitions between hadron states at $q^2 = 0$. With the use of POAC, all real photon and pion transitions fall within this domain. (JFP)

**21030** NEW FINITE-ENERGY SUM RULE IN ELECTRON–POSITRON ANNIHILATION. Sato, H. (Univ. of Maryland, College Park). Lett. Nuovo Cim.; 12: No. 2, 43-48 (11 Jan 1975).

A new kind of finite-energy sum rule is derived which enables one to predict the high energy behavior of the cross section by using the low energy experimental data. The analysis reveals a striking fact that, if one subtracts a small background contribution from the total cross section, then the residual cross section shows a scaling behavior. This result seems to suggest a two-component model for the $e^+e^-$ annihilation as a natural consequence of the finite-energy sum rule and the unitarity restriction. (JFP)

**21031** INFLUENCE OF MULTIPLE SCATTERING ON THE TOTAL AND DIFFERENTIAL COMPTON CROSS SECTIONS IN ALUMINUM. Pattison, P.; Manninen, S.; Felsteiner, J.; Cooper, M. (Univ. of Warwich, Coventry, Eng.). Phil. Mag.; 30: No. 5, 973-981 (Nov 1974).

The ratio of the elastic to the inelastic differential Compton cross section of aluminium was measured, using $^{241}$Am 59.54 keV gamma rays at a scattering angle of 150°. The sample thickness was 7 mm. A Monte Carlo procedure was used to correct the data for the effect of multiple scattering. The resultant cross section ratio of elastic to inelastic scattering was compared with the prediction of the Waller–Hartree theory, and good agreement was obtained after the multiple scattering correction had been made. The Compton profile, after applying this correction, was in agreement with a previous measurement on a thin sample, and with a calculation based on an electron-gas model including correlation. (auth)

**21032** POSSIBILITY OF ELECTRON POLARIZATION BY INHOMOGENEOUS MAGNETIC FIELDS. Osherovich, V. A. (Leningrad State Univ.). Dokl. Akad. Nauk SSSR; 215: No. 2, 317-320(11 Mar 1974). (In Russian).

The purpose of the present study was the direct mathematical demonstration of the absence of polarization of electrons with $\mu = e\hbar$ (2mc) for some classes of magnetic fields in the framework of the Pauli equations. Because of corrections to the magnetic moment of the electron, the presence of polarization in a nonhomogeneous magnetic field was obtained. (JSR)

## Weak

*Refer also to abstracts 21108, 21314, and 21316.*

**21033** (ANL-HEP-7468) CHARGED CURRENT NEUTRINO REACTIONS IN THE RESONANCE REGION. Derrick, M. (Argonne National Lab., Ill. (USA)). [nd]. 5p. (CONF-740713-38). Dep. NTIS $4.00.

From 17th international conference on high-energy physics; London, UK (1 Jul 1974).

A review is given of recent data on $\nu$ quasi elastic scattering $\nu n \to \mu^- p$, single pion production off proton and neutron targets $\nu p \to \mu^- p\pi^+$, $\nu n \to \mu^- p\pi^0$, $\mu^- n\pi^+$ and some double pion production reactions. (auth)

**21034** (CERN-74-22) PROCEEDINGS OF THE 1974 CERN SCHOOL OF PHYSICS, WINDERMERE, ENGLAND, 16-29 JUNE 1974. Kofoed-Hansen, O. (ed.). (European Organization for Nuclear Research, Geneva (Switzerland)). 30 Oct 1974. 219p. (CONF-740686-).

There were three lectures included. Separate abstracts were prepared for all lectures. (JFP)

*For abstracts of individual lectures see: 20967, 21035, and 21036.*

**21035** (CERN-74-22, pp 1-122) WEAK INTERACTIONS. Jarlskog, C. (Inst. of Theoretical Physics, Goteborg). 30 Oct 1974.

From proceedings of the CERN school of physics; Windermere, UK (16 Jun 1974).

In proceedings of the 1974 CERN school of physics.

The lectures on weak interactions cover selection rules for leptons, weak interaction experiments with leptons, muon decay and related processes, conventional theory of leptonic weak interactions, neutron beta decay and the conserved isovector current hypothesis, the decays $\pi^+ (\pi^-) \to l^+ (l^-) + \nu$ and $K^+ (K^-) \to l^+ (l^-) + \nu$, empirical facts about strangeness-changing processes, Cabibbo theory, intermediate vector bosons, and ingredients of the unified theories of weak and electromagnetic interactions (gauge theories), neutral currents, heavy leptons, and charmed particles. (JFP)

**21036** (CERN-74-22, pp 180-212) NEUTRINO INTERACTIONS. Perkins, D. H. (Oxford Univ.). 30 Oct 1974.

From proceedings of the CERN school of physics; Windermere, UK (16 Jun 1974).

In proceedings of the 1974 CERN school of physics.

A relation is shown between two lectures which are given on inclusive charge-changing weak currents and neutral weak currents. (JFP)

**21037** REMARKS ON THE TWO-COMPONENT WAVE EQUATIONS FOR MASSIVE LEPTONS. Havlicek, M.; Exner, P. (Karlova Univ., Prague). Phys. Scr.; 9: No. 3, 161-162(Mar 1974).

A two-component spin–½ equation, proposed by Biedenharn, Han and van Dam, together with critical comments of others, are discussed from the point of view of Poincaré invariance. (auth)

**21038** SCALAR MODELS OF WEAK INTERACTIONS. Segrè, G. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. Lett. 33: No. 20, 1244-1248 (11 Nov 1974).

A model of weak interactions mediated by scalar bosons $B^+$, $B^0$, and $\bar{B}^0$ is presented. (auth)

**21039** SPECULATIONS ON DETECTION OF THE "NEUTRINO SEA". Stodolsky, L. (Max–Planck–Institut für Physik und Astrophysik, Munich, Germany). Phys. Rev. Lett. 34: No. 2, 110-112 (13 Jan 1975).

If there is a high density of ambient neutrinos—a "neutrino sea"—then on the conventional weak–interaction theory two types of possibly measurable effects exist. In one the spin direction of a transversely polarized moving electron rotates in field–free space. In the other the motion of the earth creates a torque on a ferromagnet. (auth)

**21040** $\nu_\mu e$ ($\bar{\nu}_\mu e$) SCATTERING TO TEST GAUGE THEORIES AND SEARCH FOR RIGHT–HANDED NEUTRINOS. Yang, T.C.

(Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 10: No. 11, 3744-3749 (1 Dec 1974).

The scattered electron in $\nu_{\mu L}e(\bar{\nu}_{\mu L}e)$ elastic scattering has a simple angular distribution: $d\sigma/d\Omega_{c.m.} = \alpha E_{tot}^{\ 2}[1 + \frac{1}{4}b(1+\cos\theta)^2]$, where $\theta$ is the angle between initial and final electrons and a, b are two positive constants. We note that the observation of a small number of events can shed some light on the magnitude of b particularly and serve as a check for various gauge theories [similiarly for $\nu p$ ($\bar{\nu}p$) scattering, when the momentum transfer is small]. In addition, deviations from this simple angular distribution, if observed experimentally in $\nu_\mu e$ ($\bar{\nu}_\mu e$) scattering (for instance, a small peak in the backward direction), would be positive evidence for the existence of right-handed neutrinos. (auth)

**21041** MØLLER SCATTERING AND WEAK NEUTRAL CURRENTS. Gastmans, R.; Van Ham, Y. (Instituut voor Theoretische Fysica, University of Leuven, Leuven, Belgium). Phys. Rev. D 10: No. 11, 3629-3633 (1 Dec 1974).

The differential cross section to order $\alpha^3$ for the process $e^-e^- \rightarrow e^-e^-$ is calculated in the soft-photon limit, for the case of colliding electron beams with transverse polarization. The effect due to neutral weak currents in unified gauge theories is also calculated and found to be less than 1% in the Weinberg-Salam model, unless the beam energy is larger than 10 GeV. (auth)

**21042** HIGH-ENERGY BEHAVIOR OF THE TOTAL CROSS SECTIONS FOR $\nu_\mu(\bar{\nu}_\mu) + e$ AND $\nu_\mu(\bar{\nu}_\mu) + p$ SCATTERING IN SPONTANEOUSLY BROKEN GAUGE-SYMMETRY MODELS. Pi, S. (Institute for Theoretical Physics, State University of New York, Stony Brook, Long Island, New York 11790). Phys. Rev. D 10: No. 11, 3704-3713 (1 Dec 1974).

It is shown that $\lim_{s\to\infty}\sigma_{tot}(\nu_\mu + e) = \lim_{s\to\infty}\bar{\sigma}_{tot}(\bar{\nu}_\mu + e)$ and $\lim_{s\to\infty}\sigma_{tot}(\nu_\mu + p) = \lim_{s\to\infty}\bar{\sigma}_{tot}(\bar{\nu}_\mu + p)$ in models without neutral currents which couple to neutrinos. (auth)

**21043** STRUCTURE OF THE HADRONIC NEUTRAL CURRENT. Mathur, V.S.; Okubo, S.; Kim, J.E. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 10: No. 11, 3648-3652 (1 Dec 1974).

On the basis of general phenomenological arguments, it is suggested that the neutral weak hadronic current should transform as a U-spin scalar. Possible tests for this hypothesis are proposed, and the implication of the available data is discussed. The question whether such a structure can be generated from unified gauge theories is also examined. (auth)

**21044** RADIATIVE CORRECTIONS TO THE NONLEPTONIC $\Xi$ DECAYS AND THE $\Delta I = 1/2$ SELECTION RULE. Intemann, G.W. (Department of Physics, Seton Hall University, South Orange, New Jersey 07079). Phys. Rev. D 10: No. 11, 3753-3760 (1 Dec 1974).

The effects of radiative corrections on the $\Delta I = 1/2$ rule predictions for the nonleptonic $\Xi$ decays are studied. The radiative corrections are estimated using standard perturbation theory, assuming that all particles are structureless. Two different Lagrangian models are considered, and it is found that the radiative corrections are sensitive to the choice of the Lagrangian. Most of the results have the usual divergence difficulties, which are overcome with the aid of a cutoff. The results for the branching ratio $\Gamma(\Xi^- \rightarrow \Lambda^0\pi^-)/\Gamma(\Xi^0 \rightarrow \Lambda^0\pi^0)$ give a corrected value in disagreement with the latest experimental data by as much as 5.3 standard deviations. The corrections to the asymmetry parameters lead to good agreement between $\Delta I = 1/2$ and experiment. (auth)

**21045** POSSIBLE RESONANCE INTERACTIONS OF COSMIC NEUTRINOS WITH ELECTRONS AND NUCLEONS. Dedenko, L. G.; Zheleznykh, I. M.; Eidus, V. L. (Inst. of Nuclear Research, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 147-150(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 1056-1059(1974).

The cross sections for the reactions $\bar{\nu} + e^- \rightarrow W_1 \rightarrow \bar{\nu} + \mu^-$ and $\nu + Z \rightarrow \mu + W_1 + Z'$ are calculated on the basis of the Lee model with two vector mesons and two scalar mesons. The possible muon fluxes from these reactions in soil are calculated, and lower limits are estimated for the masses of the intermediate mesons on the basis of underground neutrino experiments. (auth)

**21046** HADRON PRODUCTION OF LEPTONS IN HADRON COLLISIONS. Lederman, L. (Columbia Univ., New York). pp 309-368 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The discussion of hadron production of leptons in hadron collisions covers the philosophy of a high energy physicist, the experiments, and the new accelerators. (JFP)

**21047** WEAK INTERACTION PHENOMENOLOGY. Wolfenstein, L. (Carnegie-Mellon Univ., Pittsburgh). pp 539-562 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The treatment of weak interaction phenomenology covers the standard Hamiltonian formulation, second-class currents, diagonal interactions, CP violation, and weak interactions at short distances. (JFP)

**21048** NEUTRON CURRENTS IN WEINBERG'S THEORY OF WEAK INTERACTIONS. Wolfenstein, L. (Carnegie-Mellon Univ., Pittsburgh). pp 563-580 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The question of whether there exists, in addition to the hadron current, a neutral-current term in the Hamiltonian in the Weinberg theory of weak interactions is discussed. The problem of the possible experimental detection of these neutral currents is considered using various weak interactions and their cross section relations. It is suggested that unless the assumption of isobar dominance is incorrect, the Weinberg model with neutral currents is ruled out. (JFP)

**21049** INTRODUCTION TO RENORMALIZABLE MODELS OF WEAK INTERACTIONS AND THEIR EXPERIMENTAL CONSEQUENCES. Llewellyn-Smith, C. H. (CERN, Geneva). pp 459-528 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974)

The treatment of the renormalizable models of weak interactions and their experimental consequences covers problems with the phenomenological theory of weak interactions, relevance of renormalizability, elements of renormalizable models, the example of the Georgi-Glashow model, cancellation of leading terms in the general case, generalized gauge invariance, cancellation of residual divergences and the necessity of scalar (Higgs) mesons, the Higgs model of spontaneous mass generation, recipe for model building, anomalies, and the Weinberg-Salam model. Also treated are generalities of experimental consequences, charged vector bosons, neutral currents, heavy leptons, scalar (Higgs) mesons, and charmed particles and changes of the Cabibbo angle. (JFP)

**21050** THEORETICAL ASPECTS OF WEAK INTERACTIONS IN ELECTRON-POSITRON COLLIDING BEAM EXPERIMENTS. Cung, V. K. Philadelphia; Univ. of Pennsylvania (1974). 162p. University Microfilms Order No. 75-2713.

Thesis (Ph. D.).

Various weak-interaction effects which one may hope to observe in electron-positron colliding-beam experiments are studied. Based on the fact that electron and positron beams in storage rings become transversely polarized, it is shown that the lowest-order electromagnetic amplitude of $e^+ + e^- \rightarrow \mu^+ + \mu^-$ (one-photon exchange) is suppressed in certain directions. As a result, it should be possible to detect the existence of any lowest-order-neutral-weak-current contribution to the amplitude of $e^+ + e^- \rightarrow \mu^+ + \mu^-$ via the interference of this contribution with the lowest-order electromagnetic amplitude. This interference gives rise to a "front-back" asymmetry of the differential cross section and to a longitudinal polarization of the outgoing muon. High-order-electromagnetic contributions to the amplitude of $e^+ + e^- \rightarrow \mu^+ + \mu^-$ (two-photon exchange; one-photon exchange, one-photon bremsstrahlung) which can qualitatively simulate the neutral-weak effects, are also obtained. Higher-order-weak contributions to the amplitude of $e^+ + e^- \rightarrow \mu^+ + \mu^-$, which are incalculable with a local {V-A current} × {V-A current} Hamiltonian due to badly divergent diagrams in perturbation theory, are calculated in the Georgi-Glashow model. It is shown that the S-matrix of $e^+ + e^- \rightarrow \mu^+ + \mu^-$ is gauge-parameter invariant and that the second-order-weak contribution to the $e^+ + e^- \rightarrow \mu^+ + \mu^-$ differential cross section is smaller than any first-order neutral-weak contribution by a factor $\approx Gm_w^2 \approx \alpha$. Finally, the cross sections, worked out in lowest order, of the processes $e^+ + e^- \rightarrow \mu^- + \bar{\nu}_\mu + \nu_e$ and $e^+ + e^- \rightarrow e^+ + W^- + \nu_e$ are presented. The cross section of $e^+ + e^- \rightarrow e^+ + \mu^- + \bar{\nu}_\mu + \nu_e$ is calculated as $1.5 \times 10^{-40}$ cm$^2$ at center-of-mass energy 40 GeV; observation of such a small cross section would require $e^+$, $e^-$ fluxes $\approx 10^{36}$ particle/sec-cm$^2$. The cross section of $e^+ + e^- \rightarrow e^+ + W^- + \nu_e$ is calculated as about $4 \times 10^{-38}$ cm$^2$ when the center-of-mass energy is just twice the mass of the vector boson and depends only logarithmically on this mass. A schematic method, based on the existence of a distinctive signature for the process $e^+ + e^- \rightarrow e^+ + W^- + \nu_e$, is proposed for the study of $W^-$ at center-of-mass energies below the threshold of $e^+ + e^- \rightarrow W^+ + W^-$. (Diss. Abstr. Int., B)

## Strong (General)

*Refer also to abstract 21111.*

**21051** (GIFT-3/74) STRONG INTERACTIONS AND HIGH ENERGIES. Proceedings of the IV GIFT seminar in theoretical physics, Barcelona, Spain, 11-18 April 1973. (Grupo Interuniversitario de Fisica Teorica de Altas Energias (GIFT), Zaragoza (Spain)). 1973. 430p. (CONF-730488-). Zaragoza Univ., Spain.

There were four lectures included. Separate abstracts were prepared for all lectures. (JFP)

*For abstracts of individual papers see: 20954, 20968, 20969, and 21085.*

**21052** FINITE-WIDTH EFFECTS IN RESONANCE DECAY NEAR THRESHOLD. Golowich, E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 10: No. 11, 3861-3865 (1 Dec 1974).

The decay of a resonance into a final state containing two particles, the sum of whose mean masses exceeds that of the parent particle, is investigated. Alternative methods for calculating the transition rate are compared. Two specific decays, $Y_0(1518) \rightarrow Y_1(1385)\ \pi$ and $A_2(1310) \rightarrow B(1237)\ \pi$, are studied numerically. (auth)

**21053** DIFFRACTION SCATTERING AND FACTORIZATION BELOW THE ASYMPTOTIC REGION. Finkelstein, J. (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 10: No. 11, 3783-3789 (1 Dec 1974).

Methods are described for calculating amplitudes involving the exchange of an "effective" Pomeron pole which do not depend on assumptions about the actual asymptotic behavior with energy of these amplitudes. It is shown that an "effective" Pomeron pole should (at least approximately) factorize, and should not decouple from inelastic channels even in the forward direction. (auth)

**21054** SOME MODELS FOR THE DECAY OF TIMELIKE, HIGHLY VIRTUAL PARTICLES. Mason, A. L. (Univ. of Illinois, Urbana). Phys. Rev., D; 10: No. 8, 2588-2598(15 Oct 1974).

Some tree-graph models are calculated for the decay of a timelike virtual particle. Using bare propagators and vertices there exist strong coupling solutions in which the decay rates grow with increasing energy much faster than would be predicted from the consideration of individual graphs. However, it is shown that self-energy corrections to the propagators and the condition that no ghost poles should exist lead to much more conventional behavior, whatever assumptions are made about the vertex functions. In particular, within the framework of the approximations it is shown that the $e^+e^-$ annihilation cross section must eventually decrease as $1/s$. (auth)

**21055** ROLE OF FLUCTUATIONS IN AN ANALYSIS OF $\gamma$ AND HADRON FAMILIES. Apanasenko, A. V.; Smorodin, Yu. A.; Solopov, E. M. (Lebedev Inst. of Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 76-79(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 978-982(1974).

A random sampling method and the fast-cluster model were used to determine the role of fluctuations in an analysis of $\gamma$ and hadron families. The various angular and multiplicity distributions are discussed. (JFP)

**21056** UPPER BOUND ON R(s) IN MASSIVE-QUARK MODELS FROM GENERAL PROPERTIES OF DIFFRACTION. Gensini, P. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 11: No. 16, 702-704 (21 Dec 1974).

Some interesting details are pointed out in the model of extremely massive quarks recently proposed as a general framework for exclusive and inclusive hadron physics, and in particular for processes at very high values of the invariant subenergies and momentum transfers. (JFP)

**21057** GENERALIZED MULTIPLICITY SCALING IN VERY-HIGH-ENERGY HADRON–HADRON COLLISIONS. Misra, R. C. (Univ. of Nigeria, Nsukka); Misra, K. C. Lett. Nuovo Cim.; 11: No. 16, 679-684(21 Dec 1974).

In the discussion of generalized multiplicity scaling in very high energy hadron–hadron interactions, it is considered whether it is in any way meaningful to fit the scaling functions in an ambiguous way without any physical basis or that the KNO scaling law provides consistency only for low q values. Also it is discussed to what degree in polynomial fit one can go to match the scaling function. It is proposed that for each of the $\langle n^q \rangle / \langle n \rangle^q$, where q is a positive integer and $q \geq 2$, to remain energy independent, one must have a different scaling function for each $q \geq 2$, and that each distribution function given a certain definition by the KNO scaling must satisfy the statistical requirements. (JFP)

**21058** NATURE OF HADRONIC INTERACTIONS ABOVE 100 GeV FROM COSMIC RAY EXPERIMENTS. Jones, L. W. (Univ. of Michigan, Ann Arbor). pp 125-206 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

At energies below a few TeV cosmic ray data are being overtaken by new, precise results from the I. S. R. General agreement with scaling and support for the Reggeized multiperpheral models was found, but no dramatic departures from the pattern of inclusive strong interactions as found below 30 GeV has emerged. At energies above a few TeV there are tantalizing hints that the qualitative nature of strong interactions may change. These include possible increases in total cross section and in average transverse momenta with energy, anomalous production of muons, invariant-mass clumping of $\gamma$-rays, and evidence for increasing antinucleon and kaon production. In every case the experiments may be questioned and contradictions between different groups are not infrequent. Cosmic ray physicists are continuing to search for predicted new particles such as quarks, magnetic monopoles, etc. Continuing studies of extensive air showers will still provide the only data on hadronic interactions above $10^{15}$ eV for a considerable time to come, however indirect the method may be. Attention is drawn to other areas wherein cosmic rays may make unique contributions. A particular example is the interaction between particles and complex nuclei at very high energies where unique insight into fundamental processes may be gained. (auth)

**21059** POSITIVITY THEOREM FOR SIGMA-TERMS, WITH FURTHER SPECULATIONS. Gensini, P. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 12: No. 1, 16-18(4 Jan 1975).

A previous sum rule is used to find a rigorous theorem for sigma terms. It is shown that if unitarity of partial waves holds outside the mass shell and down to $q^2 = 0$, then the sigma term is finite and positive definite whenever the lowest threshold is larger than or equal to the projectile physical mass, that is, when there are no unphysical regions below the elastic threshold. Lower bounds are found for the sigma terms for $\pi N$, Kp, and Kn, which improve the bounds already derived. (JFP)

**21060** MULTIPARTICLE PROCESSES AT HIGH ENERGIES. Simak, V. (Ceskoslovenska Akademie Ved, Prague. Fyzikalni Ustav). Acta Phys. Slovaca; 24: No. 1, 12-29(1974).

From elementary particle physics seminar; Pezinska Baba, Czechoslovakia (16 Oct 1972).

Selected features of multiparticle reactions are presented. Part I describes some results of multiplicity distributions and the possibility of scaling in the distributions. Part II presents a few basic observations as regards one-particle distributions and some recent results of exclusive reactions. The concluding part surveys the models of and theoretical approaches to multibody reactions. (auth)

**21061** DETERMINATION OF RESONANCE PARAMETERS BY THE STATISTICAL EXTRAPOLATION METHOD. Nogova, A. (Slovenska Akademia Vied, Bratislava (Czechoslovakia). Fyzikalny Ustav). Acta Phys. Slovaca; 24: No. 1, 40-46(1974).

From elementary particle physics seminar; Pezinska Baba, Czechoslovakia (16 Oct 1972).

A new method for the determination of resonance parameters from partial wave amplitude is described. Unlike previous methods, the method described makes it possible to determine directly the position of the resonance pole at the second Riemann sheet. The method is based on Cutkosky's statistical approach to the representation of data by an analytic function. The resulting value of the resonance pole position is free of ambiguities due to a specific background parametrization usual for other standard methods of determining resonance parameters. (auth)

**21062** DUAL-RESONANCE MODELS OF ELEMENTARY PARTICLES. Schwarz, J. H. Sci. Amer.; 232: No. 2, 61-67 (Feb 1975).

The development of the dual resonance models for strong interactions is described. It is noted that this theory has not yet provided any striking new experimental predictions that have been confirmed or excluded, but it successfully accounts for many general features of the hadron system. (JFP)

**21063** INTRODUCTION TO HADRONIC INTERACTIONS AT HIGH ENERGIES. Jackson, J. D. (Univ. of California, Berkeley). pp 1-103 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The lectures on hadron interactions at high energies cover total cross sections, elastic scattering, two-body processes, and inclusive interactions. (JFP)

**21064** STATISTICAL BOOTSTRAP AND THERMODYNAMIC MODEL OF HIGH ENERGY STRONG INTERACTIONS. Tounsi, A. (Institute of Nuclear Physics, Paris). pp 399-457 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The discussion of the thermodynamic model covers statistical bootstrap, the canonical description, applications to high energy collisions, scaling, limiting fragmentation, and comparison of the experimental data, and correlations. It is found that the thermodynamic model may be considered as a version of the Fermi model deeply modified by the introduction of the statistical bootstrap hypothesis. (JFP)

**21065** SCALING BEHAVIOR OF HADRONIC INTERACTIONS AND THE POINCARE GROUP. Orfandis, S. J. New Haven; Yale Univ. (1972). 92p. University Microfilms Order No. 75-4106. Thesis (Ph. D.).

The representation theory of the Poincaré group is used in constructing hadronic states appropriate for the description of fast moving nonlocal hadrons satisfying the optimal size property. These states are taken to belong to the infinite momentum frame (IMF) or Dirac basis of the Poincaré group. The nonlocality and the optimal size property is expressed by means of coherent state wave functions in internal transverse coordinate space. These states are then used in the kinematical analysis of high energy collisions of hadrons and it is shown that the Clebsch-Gordan coefficients, that appear in the reduction of two irreducible representations of the Poincaré group, exhibit scaling behavior in the various high energy kinematical limits such as the Bjorken, Feynman, or limiting fragmentation limits. Position operators are constructed for timelike and spacelike representations of the Poincaré group in a unified way. A unified treatment of the Gelfand-Naimark Z-bases for all irreducible representations of the timelike, spacelike and lightlike little groups is also presented and all the unitary irreducible representations of the $SU_{1,1}$ group are expressed in a compact way through the use of a Hilbert space metric operator. (Diss. Abstr. Int., B)

## *Strong (Baryon No. = 0)*

*Refer also to abstracts 21110 and 21332.*

**21066** (JINR-P1-8401) S-WAVE $\pi\pi$ SCATTERING LENGTHS FROM THE ANALYSIS OF THE $\pi N \to \pi\pi N$ REACTIONS NEAR THE THRESHOLD AND $K \to 3\pi$ DECAYS. Bunyatov, S. A.; Gulkanyan, G. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 25p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

From the analysis of the total cross sections of the $\pi N \to \pi\pi N$ reactions near the threshold within the "soft" pion theory and from the analysis of the data on $K \to 3\pi$ decays on the basis of the semiphenomenological theory of three strong-interacting particle production near the threshold, it was found that the most probable values of the S-wave $\pi\pi$ scattering lengths in the isotopic states $T = 0$ and $T = 2$ are within the limits: $(0.17 \pm 0.01)$ $m_\pi^{-1} < a_0 < (0.59 \pm 0.07)$ $m_\pi^{-1}$ and $-(0.20 \pm 0.03)$ $m_\pi^{-1} < a_2 < -(0.045 \pm 0.005)$ $m_\pi^{-1}$. (auth)

**21067** INELASTICITY PARAMETERS OF $\pi\pi$ SCATTERING. Baker, R.D. (Indian Institute of Technology, Bombay, India). Phys. Rev. D 10: No. 11, 3826-3828 (1 Dec 1974).

We predict the inelasticity $\eta$ of $\pi\pi$ P and F waves using Veneziano model for $\pi\pi \to \pi\omega$. The scale of the Veneziano amplitude is fixed from the $\omega$ width in $\omega \to 3\pi$ decay. (auth)

**21068** $f^0 \to 4\pi$ DECAY IN A RELATIVISTIC QUARK MODEL. Parashar, D. (Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822). Phys. Rev. D 10: No. 11, 3884-3887 (1 Dec 1974).

On the basis of a relativistic version of the phenomenological couplings among hadrons in the broken SU(6) × O(3) quark model developed largely by Mitra, we calculate the decay width and the corresponding branching ratio for the four-body decay process $f^0 \to 4\pi$. In addition, we assume that the dominant contribution to the process $f^0 \to 4\pi$ comes from the mechanism $f^0 \to A_1\pi(\rho\pi)\pi \to 4\pi$. The model makes a very interesting prediction for the branching ratio $\Gamma(f^0 \to \pi^+\pi^+\pi^-\pi^-)/\Gamma(f^0 \to \pi\pi)$, which turns out to be 3.1%, in excellent agreement with the recent experimental value of $(3.7 \pm 0.7)\%$ determined by Anderson et al. (auth)

**21069** ENHANCEMENT OF $\omega\pi^0$ AND OTHER SYSTEMS IN MISSING-MASS FINAL STATES. Mikenberg, G. (Department of Nuclear Physics, Weizmann Institute of Science, Rehovot, Israel). Phys. Rev. D 10: No. 11, 3889-3891 (1 Dec 1974).

A method of enhancing $\omega\pi^0$ and $\eta\pi^0$ systems in missing-mass final states is described. In addition to simple kinematical arguments, dynamical considerations are applied to yield some information on the spin and parity of the $\omega\pi^0$ ($\eta\pi^0$) system. (auth)

**21070** RELATIVISTIC PROPAGATORS FOR $\pi\pi$ RESONANCES AND THE NN INTERACTION. Nack, M.L.; Ueda, T.; Green, A.E.S. (Department of Physics and Astronomy, University of Florida, Gainesville, Florida 32601). Phys. Rev. D 10: No. 11, 3617-3628 (1 Dec 1974).

A relativistic resonance propagator is presented whose form is guided by an approximation to the full S matrix, utilizing K-matrix unitarization of the lowest-order quantum-field-theory perturbation term. This propagator is designed to fit the full S matrix and therefore the corresponding phase-shift data, and to also satisfy a threshold scattering-length relationship. The formalism is generalized to include the propagation of a system of resonances on an individual phase shift, such as occurs on the $\pi\pi$ S wave. A dispersion relation is then used to obtain the corresponding spectral function (or mass-squared distribution). The influence of inelasticity is considered. This model is fitted to several $\pi\pi$ S- and P-wave phase-shift solutions. The spectral functions so obtained can be used in calculations of the $\pi\pi$-system exchange contributions to the NN interaction. The implications of these spectral functions upon the nonrelativistic configuration-space one-boson exchange potential for the NN interaction as well as upon the corresponding relativistic momentum-space potential for use with the Bethe-Salpeter equation are discussed. (auth)

**21071** DUAL RESONANCE MODEL OF INCLUSIVE VECTOR MESON PRODUCTION. Randa, J. P. Urbana, IL; Univ. of Illinois (1974). 142p. University Microfilms Order No. 75-409. Thesis (Ph. D.).

Expressions are obtained for the cross section and density matrix elements of vector mesons produced in inclusive reactions by evaluating the imaginary parts of certain multiparticle Veneziano model amplitudes. The behavior of these quantities as functions of energy, missing mass, and momentum transfer is explored for small values of the momentum transfer. As a start, the DeTar, Kang, Tan, and Weis's method is applied for taking imaginary parts of the appropriate residue of the Veneziano $B_8$ function of Chan and Tsou. This provides a simple model both for the vector meson production quantities and (using $B_6$ instead of $B_9$) for the single-particle spectrum for the production of pseudoscalar mesons. The work is then extended to include both abnormally coupled trajectories and trajectories with positive intercept. Differential cross sections and density matrix elements for the vector mesons are compared with those from the simpler calculations. The single-particle spectrum for spinless particles is also obtained and compared to earlier results. (Diss. Abstr. Int., B)

**21072** ROLE OF TWO-STEP CONTRIBUTIONS IN NUCLEAR COHERENT AND INCOHERENT PION PRODUCTION. Faeldt, G.; Osland, P. Ark. Fys. Seminar Trondheim; No. 13, 1-29(1974).

The recent CERN measurements of $3\pi$ and $5\pi$ production on nuclear targets are analyzed in terms of one- and two-step production. It is argued that the low value of the $5\pi$-nucleon total cross section is an effect which can be ascribed to interference between one- and two-step terms. For the $A_3$ case the evidence for two-step contributions is at present rather weak. (auth)

**21073** PADE APPROXIMANT CALCULATIONS WITH THE SIGMA MODEL: PION-PION SCATTERING AND THE PION FORM FACTOR. Betlach, T. L. San Diego, CA; Univ. of California (1974). 224p. University Microfilms Order No. 75-4631. Thesis (Ph. D.).

The sigma model is renormalized using a method that manifestly preserves the symmetry properties on which the model is based. The results are used to construct Padé approximants to the pion electromagnetic form factor and the pion-pion scattering amplitude. The sensitivity of results with respect to purely conventional choices in the renormalization procedure is investigated. Numerical results are presented and discussed. (Diss. Abstr. Int., B)

## *Strong (Baryon No. = 1)*

*Refer also to abstracts 21120, 21322, and 21323.*

**21074** (ITEF-69) STUDY ON THE $\pi^-p \to \pi^+\pi^-n$ REACTION AT 4.5 GeV/c WITHIN THE FRAMEWORK OF THE ONE-PION EXCHANGE REGGE MODEL. Nilov, A. F.; Beketov, G. V.; Boreskov, K. G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 18p. (In Russian). INIS.

Processing and analysis were carried out on 4819 events of the reaction $\pi^-p \to n\pi^+\pi^-$ at a 4.5 GeV/c momentum of the incident $\pi^-$-meson. A value of $0.64 \pm 0.10$ mb was obtained for the forma-

tion cross section of $\rho^0$-mesons, while a value of 0.29 ± 0.08 mb was obtained for the formation cross section $f^0$-mesons. A satisfactory agreement of experimental distributions with those predicted from a model of Regge, single-pion exchange is shown. (tr-SJR)

**21075** (JINR-E2-8213) SATURATION OF ISOSPIN BOUNDS AND CONSTRAINTS ON EXPERIMENTAL DATA AND AMPLITUDE ANALYSIS IN $\pi$ N-SCATTERING. Ion, D. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 33p. Dep. NTIS (US Sales Only) $4.75.

New and interesting isospin bounds in the pion–nucleon scattering are proven, and their saturations are investigated using the CERN-phase shift analysis. These isospin bounds are exactly saturated along certain lines in ($p_{LAB.}$, cos $\theta$)-plane, and strong constraints are imposed on experimental data and amplitude analyses. Also, constraints are obtained on data and amplitude analysis when different isospin bounds are saturated or degenerated. (auth)

**21076** (JINR-E2-8375) MODEL OF $\pi$N-INTERACTIONS. S-WAVE LENGTHS AND PROTON–NEUTRON MASS DIFFERENCE. Ivanov, M. A.; Malyshkin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. Dep. NTIS (US Sales Only) $4.00.

A model of $\pi$N-interaction with the pseudovector coupling is considered. It is shown that the summation principle of Redmond–Bogolubov–Logunov–Shirkov, applied to some self-energy diagrams of the second order for the nucleon Green function, and an appropriate regrouping of the perturbation theory expansion result in the super-renormalizable model. Within the framework of this model the $\pi$N s-wave scattering length and the neutron–proton mass difference are calculated. (auth)

**21077** QUARK PAIRING AND ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFER. Gunion, J.F. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). Phys. Rev. D 10: No. 11, 3684-3690 (1 Dec 1974).

We reassess interchange-theory predictions for elastic meson-baryon and baryon–baryon reactions in light of the apparent quark pairing within the proton. The theoretical forms are compared to existing data. (auth)

**21078** MULTIPLICITY BEHAVIOR OF $\pi^- p \to pX$: A MULTIPERIPHERAL–MODEL DESCRIPTION. Chan, C. F.; Winkelmann, F.C. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 10: No. 11, 3645-3648 (1 Dec 1974).

For the inclusive reaction $\pi^- p \to pX$, the average charged multiplicity $\langle n \rangle$ of the system X as a function of missing mass $M^2$ and momentum transfer t is studied in terms of a multiperipheral model. For $M^2 \gtrsim 20$ GeV$^2$ (above the low–mass pion diffraction region) and for $|t| \lesssim 1$ GeV$^2$, the model is found to be in good agreement with data at 205 GeV/c, which show $\langle n(M^2, t) \rangle \sim \ln M^2$ for fixed t, and $\langle n(M^2,t) \rangle$ only weakly dependent on t for fixed $M^2$. Further experimental and theoretical investigation is suggested. (auth)

**21079** CORRECTIONS TO THE MASS AND WIDTH OF A RESONANCE. Lichtenberg, D.B. (Physics Department, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 10: No. 11, 3865-3867 (1 Dec 1974).

The lowest–order correction to the mass of a Breit–Wigner resonance with an energy–dependent width goes as the width squared, while the lowest–order correction to the width goes as the width cubed; and, in the case of hadron resonances near threshold, the corrections act to reduce the mass and width. Applications to the $\Delta$ (1232), $\Sigma^*$ (1383), and $\Xi^*$ (1530) are given. (auth)

**21080** PRODUCTION OF LARGE–TRANSVERSE–MOMENTUM MESONS FROM A MESON BEAM. Combridge, B.L. (Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, England). Phys. Rev. D 10: No. 11, 3849-3853 (1 Dec 1974).

The Landshoff–Polkinghorne quark–fusion model for the production of large–transverse–momentum mesons from high–energy hadronic processes is applied to meson–nucleon collisions. A second, leading–particle, contribution from large–angle scattering of the incident meson is included in the calculation and has the same power dependence on $p_T$ at fixed $p_T/\sqrt{s}$ and fixed center-of-mass scattering angle. Numerical calculations are presented for $\pi^+ p \to M + X$ assuming SU(3) couplings of quarks to the pseudoscalar mesons M. Mainly because of the leading–particle effect, some of the cross sections are substantially higher than in proton–proton collisions. Although the over–all normalization is obtained by fitting just the quark–fusion model to the experimental data on $pp \to \pi + X$ at large $p_T$, it is estimated that the choice of normalization is not substantially changed by the inclusion in this fit of the hadronic bremsstrahlung process proposed by Blankenbecler, Brodsky, and Gunion. (auth)

**21081** PION–NUCLEON COLLISIONS AT ACCELERATOR ENERGIES. Didenko, L. A.; Murzin, V. S.; Sarycheva, L. I.; Smirnova, L. N.; Shcheglova, L. M. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 60-62(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 962-964(1974).

The properties of asymmetric and symmetric $\pi_p$ collisions at 40 GeV/c are compared. The pion-pion cluster which appears in an asymmetric collision cannot be described by means of the statistical model. (auth)

**21082** COMPOSITE HADRONS AND DEEP SCATTERING. Blankenbecler, R. (Stanford Linear Accelerator Center, CA). pp 3-75 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

The discussion of composite hadrons and deep scattering covers a relativistic description of composite states, form factors, time orderings and channel Hamiltonians, elastic and quasi-elastic scattering. Resonance production, pion–nucleon, kaon–nucleon, and nucleon–nucleon are discussed in detail. Also continuation to the crossed annihilation and a summary of results on inclusive scattering are included. (JFP)

**21083** AMPLITUDE STRUCTURE IN PSEUDOSCALAR–MESON BARYON SCATTERING. Matthews, J. A. J. (Stanford Linear Accelerator Center, CA). pp 635-680 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

Recent analyses are reviewed that determine the amplitude structure of meson–baryon scattering directly from the data. Harari's explanation of the "crossover" effect in elastic scattering is introduced, motivating the evaluation of $\omega^0$ and $f^0$ exchange amplitudes from the data. Uncertainties in the analysis of the $f^0$ amplitude are detailed, and are noted to arise from the uncertainty in the pomeron contribution to elastic scattering. Finally, the dual absorptive model (DAM) of Harari is presented and compared to data on charge exchange and strangeness exchange reactions. Particular emphasis is placed on the comparison of the DAM to the crossed reactions $\pi p \to K(\Lambda, \Sigma)$ and $\bar{K} p \to \pi(\Lambda, \Sigma)$. (auth)

**21084** PROBLEM OF MASS QUANTIZATION. Papini, G. (Univ. of Regina, Saskatchewan). Lett. Nuovo Cim.; 12: No. 2, 37-38(11 Jan 1975).

An equation is derived for the mass quantization of the proton which is very appealing in that the mass of the proton appears to be determined by the total amount of mass in the universe. Equivalently one can say that the proton wavelength relative to the size of the universe depends on the amount of matter in it, a result truly Machian in character. (JFP)

## *Strong (Baryon No. ≥ 2)*

*Refer also to abstracts 20952, 21127, 21151, and 21155.*

**21085** (GIFT-3/74, pp 1-83) INELASTIC INTERMEDIATE STATES IN THE INTERACTION OF HIGH ENERGY PARTICLES WITH NUCLEI. Bertocchi, L. (Univ., Trieste, Italy). 1973.

From 4th GIFT seminar in theoretical physics; Barcelona, Spain (11 Apr 1973).

In strong interactions and high energies.

The lectures on the theory and possible relevance of the inelastic intermediate states for the elastic and inelastic coherent reactions covers particle-deuteron cross section defect, inelastic screening in deuterium, hadron–nucleus total cross sections, inelastic intermediate states in coherent production, interaction of high energy photons with nuclei, coherent hadroproduction, and the coupled-channel optical model. (JFP)

**21086** RELATIVISTIC OSCILLATOR MODEL OF HIGH–ENERGY INTERACTIONS. Osborne, L.S. (Physics Department and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. Lett. 34: No. 2, 106-110 (13 Jan 1975).

I present a model of hadrons composed of relativistic quarks in bound oscillator states. The model gives a good account of the multiplicity, distribution in momentum, and particle ratios for high–energy proton–proton collisions. (auth)

**21087** THEORETICAL MODELS FOR PROTON–PROTON ELASTIC POLARIZATION. Hendry, A.W.; Abshire, G.W. (Physics

Department, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 10: No. 11, 3662-3666 (1 Dec 1974).

We apply various theoretical models to proton–proton elastic polarization for $-t \lesssim 6$ (GeV/c)$^2$ at 12.33 GeV/c, where pronounced structure has recently been observed. (auth)

**21088** COMMENT ON THE DEFINITION OF THE NUCLEON–NUCLEON POTENTIAL. Gersten, A. (Department of Physics, Ben–Gurion University of the Negev, Beer–Sheva, Israel). Phys. Rev. D 10: No. 11, 3892-3894 (1 Dec 1974).

A procedure is outlined for the definition of a nucleon–nucleon potential resulting from approximate Bethe–Salpeter equations for the two–nucleon system. In particular, the potentials obtained from the equations derived by Partovi and Lomon and by Thompson are discussed. (auth)

**21089** PROTON–NUCLEUS CROSS SECTIONS AND THE PERIPHERAL COMPONENT OF ELASTIC SCATTERING. Pumplin, J. (Department of Physics, Michigan State University, East Lansing, Michigan 48824). Phys. Rev. D 10: No. 11, 3736-3739 (1 Dec 1974).

A model of proton–proton scattering is presented in which $\sigma_{pp}$ rises with energy due to large–impact–parameter effects which are associated with the two–pion–exchange cut. The model is applied to the question of determining $\sigma_{pp}$ from proton–nucleus interactions of cosmic rays. (auth)

**21090** NOTE ON TWO–PARTICLE CORRELATIONS IN TWO–COMPONENT MODELS. Jabs, A. (Universität Trier–Kaiserslautern, Fachbereich Physik, D–675 Kaiserslautern, Germany). Phys. Rev. D 10: No. 11, 3881-3884 (1 Dec 1974).

The two–particle correlation function $f_2 = \langle \Delta n \rangle^2 - \langle n \rangle$ is calculated for the case where two independent incoherent mechanisms simultaneously contribute to high–energy particle production. It is pointed out that a possible discrepancy between $f_2$ values observed in pp collisions and in pure $\bar{p}p$ annihilation events could be explained in terms of the phase–space description of the pionization component. (auth)

**21091** PION PRODUCTION IN HIGH–ENERGY COLLISIONS. Wang, C.L. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 10: No. 11, 3876-3878 (1 Dec 1974).

It is noted that the pion production by 200– and 300–GeV/c protons is in agreement with the prediction of an empirical formula, which is generally applicable to high–energy proton–light–nucleus collisions as well as to proton–proton collisions. (auth)

**21092** TRIANGLE–MODEL CALCULATIONS AND A PHENOMENOLOGY OF TRIPLE–REGGE COUPLINGS. Harrington, S.; Ng, J.N. (Department of Physics, University of Washington, Seattle, Washington 98195); Dash, J.W. Phys. Rev. D 10: No. 11, 3840-3848 (1 Dec 1974).

We utilize triangle models for triple–Regge couplings in order to constrain inclusive phenomenology. Detailed two–body scattering amplitude data at intermediate energies serve to specify most parameters in the model. We obtain qualitative agreement with inclusive data for $pp \to pX$ using only two unconstrained parameters. (auth)

**21093** DUAL FOUR–POINT FUNCTIONS WITH NO NEGATIVE RESIDUES. Coon, D.D.; Yu, S. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). Phys. Rev. D 10: No. 11, 3780-3783 (1 Dec 1974).

The positivity of residues in a general class of dual four–point functions is studied. A large domain in parameter space [$\alpha$ (0), $\alpha'$ (0), trajectory curvature, external mass] is found in which there are no negative residues at any level. The ghost–free domain of $\alpha$ (0) expands as the positive curvature of the trajectory is increased. This suggests departure from linearity of trajectory as a way of breaking the $\alpha$ (0) = 1 no–ghost condition for the Veneziano N–point function. For a set of parameters which provides a good fit to the nondiffractive component of proton–proton elastic scattering, it is shown that the amplitude has no negative residues. (auth)

**21094** ANGULAR DISTRIBUTIONS OF PARTICLES FROM INCLUSIVE HADRON–NUCLEUS REACTIONS AND SCALING VERY HIGH ENERGIES. Eliseev, S. M.; Murzin, V. S.; Sarycheva, L. I. (Scientific-Research Inst. of Nuclear Physics, Moscow). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 63-65(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 965-967(1974).

An attempt was made to determine how the angular characteristics of secondary particles in nucleon–nucleus collisions vary with the atomic number of the target nucleus. The characteristics were carried out by the Monte Carlo method on the basis of the model of intranuclear cascades. The cross sections and angular distributions are considered. (JFP)

**21095** SECONDARY-PARTICLE MULTIPLICITY AS A FUNCTION OF THE ATOMIC NUMBER OF THE TARGET NUCLEUS AND THE ENERGY OF THE INCIDENT PARTICLE. Atanelishvili, M. I.; Berdzenishvili, O. L.; Vervetskii, Yu. G.; Garsevanishvili, L. P.; Gromov, Yu. A.; Lomtadze, T. A.; Kotlyarevskii, D. M.; Matsaberidze, V. F.; Struchalina, A. V.; Chikovani, L. D.; Tsomaya, P. V.; Shtemanetyan, G. Z. (Inst. of Physics, Tbilisi, USSR). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 16-18(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 915-917(1974).

The increase in the multiplicity for various materials (H, $CH_2$, Al, and Cu) over the energy range 50 to 3000 GeV is described satisfactorily by a logarithmic law. The coefficient of the logarithm increases with increasing atomic number, but the data agree with the predictions of semi-inclusive scaling. (auth)

**21096** CONSTRAINTS ON THE CHARGED-MULTIPLICITY DISTRIBUTION FROM NEUTRAL-CHARGED-PARTICLE CORRELATIONS. Gupta, V. (CERN, Geneva), Lett. Nuovo Cim.; 11: No. 15, 668-672(14 Dec 1974).

The problem of the n_dependence of $\bar{N}_0(n_-)$ (the average number of neutrals for a given number $n_-$ of negatively charged particles) was previously studied using various models for $P(n_-)$ (the probability of producing $n_-$ negatively charged particles). This problem is considered taking the dependence of $\bar{N}_0(n_-)$ on $n_-$ as known. This coupled with some simple assumption about the higher neutral-negative correlations gives constraints on $P(n_-)$ in the form of recurrence relations. These then enable one to calculate or predict the $P(n_-)$ given some input from the experimental data. The cross section for $n_-$ negative particles was calculated for pp collisions from 50 to 405 GeV/c. (JFP)

**21097** COHERENT MESON PRODUCTION IN NUCLEON–NUCLEON INTERACTIONS. Takibaev, Zh. S.; Magzumov, E. Zh.; Zaitsev, K. G. (Inst. of High-Energy Physics, Alma-Ata, USSR). Dokl. Akad. Nauk SSSR; 214: No. 6, 1295-1298(21 Feb 1974). (In Russian).

The criteria for the selection of events of coherent meson production were formulated. On the basis of an analysis of 12 cases of coherent meson production an expression was derived for the amplitude of the coherent production process. The number of scattering centers in the nucleon A was evaluated as $A \lesssim 10$. The same value was obtained from a comparison of the theoretical and experimental differential cross sections for elastic pp scattering. (JSR)

**21098** PHENOMENOLOGICAL MODELS OF ELEMENTARY PARTICLE STRUCTURE. Carriere, E. W. Baton Rouge, LA; Louisiana State Univ. (1974). 87p. University Microfilms Order No. 75-1917.

Thesis (Ph. D.).

The trajectory problem is examined in several crude, composite models and evidence of spin–isospin correlations in the baryon resonance spectrum is presented; and it is shown that this behavior may be reproduced in an ad hoc phenomenological mass operator model. Certain features of these models are abstracted and incorporated in a more general model in which baryons are considered as consisting of a cloud and core structure. Some of the global features of high energy scattering experiments are investigated in this cloud model in addition to the trajectory problem and the spin–isospin correlations. Finally, a multi-local field theory of the Yukawa type, employing a mass squared operator is investigated. The trajectory problem is examined for a simple model mass operator. Form factors and vertex functions are calculated, and their effects on high energy elastic scattering are examined. The model mass operator is linearized and a Dirac-like equation is obtained. The results are then discussed. (Diss. Abstr. Int., B)

**21099** USE OF THE NAL ACCELERATION RAMP TO STUDY INCLUSIVE REACTIONS. Pagnamenta, A. (Univ. of Illinois, Chicago). pp 681-704 of Proceedings of the Canadian Institute of Physics Summer School. Henzi, R. (ed.). Montreal; McGill University (1972).

From institute of particle physics summer school; Montreal, Canada (28 Aug 1972). See CONF-720868-.

It is shown how a standard missing mass experiment, set up to search for resonances, can make use of the NAL accelerator ramp to investigate several interesting aspects of inclusive reactions. Attention is called to a refinement and simplified version proposed previously. The reaction $p + p \to p +$ anything only, but the technique is more general and easily applied to $pp \to C + X$, $\pi p \to C + X$, where C can be $\pi^+$, $\pi^-$, $\gamma$, K, or n. The kinematics, scaling, the triple Regge formula, and related experiments are discussed. Much of the treatment is speculative. (JFP)

**21100** ESTIMATE OF THE CROSS SECTIONS FOR $\pi^+$ + NUCLEUS → $K^+$ + HYPERNUCLEUS. Alves, S. M. C. Laramie, WY; Univ. of Wyoming (1974). 92p. University Microfilms Order No. 75-204.

Thesis (Ph. D.).

An estimate of the cross sections for the reaction $\pi^+$ + nucleus → $K^+$ + hypernucleus was carried out for the $^4$He, $^7$Li and $^{119}$Sn target nuclei, with incident pion energies both below and above the threshold for associated production $\pi^+n \rightarrow K^+\Lambda$ from a free neutron. The impulse approximation was used to express the T-matrix elements of the interaction in terms of the $\pi^+n \rightarrow K^+\Lambda$ free t-matrix elements, assuming a $K^*$ meson exchange model for the reaction $\pi^+n \rightarrow K^+\Lambda$. For the production of the $^4_\Lambda$He hypernucleus, a Gaussian wave function was assumed for the $^4$He target, along with a variational $\Lambda$-$^3$He correlation function for the $^4_\Lambda$He hypernucleus. The production of $^7_\Lambda$Li was examined with square well and cluster wave functions for the $^7$Li target and final $^7_\Lambda$Li hypernucleus. The production of the $^{119}_\Lambda$Sn hypernucleus was also examined with a square well model for the target nucleus and for the hypernucleus produced. For $\pi^+$ lab energies below 650 MeV all the cross sections were quite small. For the $^4_\Lambda$He ground state production, the $K^+$ mesons are forward peaked and the total cross sections are of the order of tenths of microbarns. The cross sections for the $^4_\Lambda$He* excited state production are ~$10^3$ times smaller, with the peak in the angular distribution of the energent kaons being moved to about 20°. In the $^7_\Lambda$Li ground state production, the total cross section per neutron are in the order of tenths of microbarns, with the relative production rate $^7_\Lambda$Li/$^7_\Lambda$Li* being of the order of $10^2$. The total cross section per neutron for producing $^{119}_\Lambda$Sn is smaller, of the order of thousandths of microbarn, but now the production of excited states $^{119}_\Lambda$Sn* is favored with respect to the production of the $^{119}_\Lambda$Sn ground state. (Diss. Abstr. Int., B)

**21101** PROTON-INDUCED PRODUCTION OF NEGATIVE PIONS ON $^9$Be. Dillig, M.; Huber, M. G. (Univ. of Erlangen, Ger.). Lett. Nuovo Cim.; 11: No. 17, 728-732(28 Dec 1974).

In the method used the nucleus is treated in a more realistic way by introducing short-ranged correlations between nucleons via a two-body correlation factor, whereas the pion–nucleon interaction is taken to be the nonrelativistic Galilei-invariant pseudoscalar–pseudoscalar interaction. Properties of the differential cross sections for the (p,$\pi^-$) reaction on beryllium-9 are discussed. The results indicate that in the framework of the Jastrow model the absorption as well as the production of charged pions can be explained consistently with the correlation parameter. (JFP)

**21102** KINEMATICAL EFFECTS, NEUTRAL-CLUSTER MODELS AND NEUTRAL-TO CHARGED-PION CORRELATIONS IN MULTIPARTICLE PRODUCTION. Arneodo, A.; Kubar-Andre, J. (Univ., Nice). Lett. Nuovo Cim.; 12: No. 1, 1-8(4 Jan 1975).

It is argued that a very strong damping of the multiplicity distribution of negative pions can occur at Serpukhov and early NAL energies. It is shown that such a strong damping of the negative multiplicity distribution allows one to reproduce the experimental tendency of $\overline{n_0}$ ($n_-$) to decrease for large values of $n_-$. The cluster model framework is used, and for specific calculations the $\rho$-$\rho$ model is used as an example. The importance of kinematical effects on the behavior of the negative multiplicity distribution and on the correlations between neutral and charged pions is emphasized. (JFP)

**21103** FIELD THEORETICAL NUCLEON–NUCLEON INTERACTION. VerWest, B. J. Stony Brook, NY; State Univ. of New York (1974). 159p. University Microfilms Order No. 75-5101.

Thesis (Ph. D.).

The field theoretical nucleon–nucleon interaction is studied with emphasis on the correct handling of the short-range and nonlocal contributions. The momentum space formalism for this problem is reviewed in the framework of the Blankenbecler–Sugar equation. The one-boson-exchange potential is constructed from field theoretical Lagrangians, and the two-pion-exchange contribution is calculated using the dispersion theory construction which allows the inclusion of information on the processes $\pi N \rightarrow \pi N$ and $N\bar{N} \rightarrow \pi\pi$. The two-pion-exchange potential is constructed by removing from the field theoretical amplitude the iteration of the one-pion-exchange potential. The Blankenbecler–Sugar equation is used for this iteration. The potential is regularized using relativistic eikonal form factors. The partial wave equations are solved numerically to obtain the phase parameters using an optimal conformal mapping. Comparisons are made with the results of experimental data analyses. The deuteron bound state is studied and the binding energy, wave functions, and form factors are calculated. The potential is shown to have significantly weaker short-range repulsion than most phenomenological potentials. In a separate calculation, the $\omega pp$ coupling constant is determined using the pp forward dispersion relation. The discontinuity across the unphysical cut in the pp forward amplitude is represented by one-meson and two-pion-exchange contributions. The real part of the forward amplitude is constructed from pp phase shift analyses below 460 MeV laboratory frame kinetic energy. The dispersion integrals are calculated using pp and $\bar{p}p$ total cross sections and the optical theorem. The meson-nucleon coupling constants are obtained by a fitting process. The $\omega pp$ coupling constant is obtained using several models for the two-pion-exchange contribution, and the values are in the range $14. \leq g_\omega^2/4\pi \leq 20.$ (Diss. Abstr. Int., B)

# Particle Invariance Principles and Symmetries

## General

**21104** BROKEN SYMMETRY AND THE COSMOLOGICAL CONSTANT. Dreitlein, J. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302). Phys. Rev. Lett. 33: No. 20, 1243-1244 (11 Nov 1974).

The hypothesis that the Higgs field has also a cosmological character is proposed. The experimental consequences are an upper limit on the mass of the scalar boson, $m_\varphi < 4.6 \times 10^{-27} m_e$, and an implication that the universe will recontract. (auth)

**21105** CASIMIR OPERATORS OF COMPLEMENTARY UNITARY GROUPS. Aguilera-Navarro, M. C. K. (Univ., Sao Paulo, Brazil). J. Math. Phys. (N. Y.); 16: No. 1, 72-74(Jan 1975).

A relation between all the generalized Casimir operators of complementary unitary groups is derived, both in the fermion and boson realizations of the corresponding Lie algebras. It is shown that the number of independent Casimir operators of unitary groups reduces essentially to half the number of self-conjugate irreducible representations. (auth)

**21106** UNITARY SPINORS IN THE LORENTZ GROUP. Huszar, M. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Acta Phys. Slovaca; 24: No. 1, 3-11(1974).

From elementary particle physics seminar; Pezinska Baba, Czechoslovakia (16 Oct 1972).

Matrix elements of the principal series of unitary representations of the Lorentz group are investigated. For this purpose, the notion of the finite-dimensional spinor is generalized to the unitary case. In this basis representations take a form analogous to the three-dimensional rotation group and are much simpler than those in angular momentum basis. (auth)

**21107** SPONTANEOUS SYMMETRY BREAKING. Higgs, P. W. (Univ. of Edinburgh). pp 529-552 of Phenomenology of Particles at High Energies. Crawford, R. L.; Jennings, R. (eds.). New York; Academic Press Inc. (1974).

The discussion of spontaneous symmetry breaking covers exact and broken symmetries, the Bogoliubov model of a superfluid, photon- and plasmon-like excitations, the Goldstone theorem for relativistic models, the Goldstone model, how to evade the Goldstone theorem in gauge theories, Gauge invariance and mass, and spontaneous breaking of a local symmetry: the gauge invariant extension of the Goldstone model. (JFP)

## Applications (Electromagnetic and Weak)

*Refer also to abstracts 21011 and 21044.*

**21108** EXPERIMENTAL TEST FOR CP NONINVARIANCE AND NEUTRAL KAON "CHARGE". Hsu, J.P. (Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 10: No. 11, 3836-3839 (1 Dec 1974).

We discuss a theory of CP noninvariance in which the interaction is completely determined by the principle of gauge invariance. We also discuss its experimental test by observing anomalous phenomena of $K^0$ decay in the electric field. Moreover, the experimental result can also determine an accurate upper limit for the neutral kaon charge (which has never been directly measured) if the predicted phenomena are not observed. (auth)

## Applications (Strong)

**21109** RELEVANCE OF SOME RECENT NEUTRON–PROTON POLARIZATION DATA TO T VIOLATION AT INTERMEDIATE

ENERGIES. Bryan, R.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544 and Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712). Phys. Rev. D 10: No. 11, 3854-3856 (1 Dec 1974).

We comment on some neutron–proton polarization data taken by Leung, Kerth, and Surko at 520 and 600 MeV, and compare these data with n–p asymmetry measurements taken by Cheng, MacDonald, Helland, and Ogden at 500 and 600 MeV. The two sets of data agree within experimental error, thus ruling out any T asymmetry in n–p scattering at intermediate energies greater than a few percent. We point out the relevance of this to a T–asymmetric nucleon–nucleon potential model developed by Bryan and Gersten. (auth)

**21110** $SU_3$ NONINVARIANCE OF THE VACUUM AND THE CHIRAL–$SU_2 \times SU_2$–BREAKING PARAMETER. Ebrahim, A.: Serdaroğlu, M. (Physics Department, Middle East Technical University, Ankara, Turkey). Phys. Rev. D 10: No. 11, 3869-3871 (1 Dec 1974).

The effect of $SU_3$ noninvariance of the vacuum (i.e., $f_\pi + f_K + f_\eta$) on the chiral–$SU_2 \times SU_2$–breaking parameter of Gell–Mann, Oakes, and Renner, and on the Gell–Mann–Okubo mass formula for the pseudoscalar meson octet is calculated in a nonlinear Lagrangian model of broken chiral $SU_3 \times SU_3$ symmetry. (auth)

**21111** CHIRAL PERTURBATION THEORY AND THE MAGNETIC MOMENTS OF THE BARYON OCTET. Caldi, D.G.; Pagels, H. (The Rockefeller University, New York, New York 10021). Phys. Rev. D 10: No. 11, 3739-3743 (1 Dec 1974).

We have calculated, exactly to leading order in the chiral perturbation symmetry–breaking parameter $\epsilon$, the corrections to the Coleman–Glashow SU(3) relations among the magnetic moments of the baryon octet. The corrections are of order $\epsilon^{1/2}$. In general the corrections turn out to be at least as large as the zeroth–order term, and hence the perturbation expansion breaks down. We discuss the reasons for this breakdown. We also derive sum rules which are independent of the leading–order corrections and hence valid to next order in chiral perturbation symmetry breaking, i.e., $\epsilon \ln \epsilon$. (auth)

**21112** GEOMETRY OF THE SU(3) GROUP AND THE MASS FORMULA FOR MESONS. Epstein, J. S. New York; New York Univ. (1974). 87p. University Microfilms Order No. 74-29,976.

Thesis (Ph. D.).

A geometrical model is investigated for the $SU_3$ or $U_3$ symmetry of strongly interacting particles. The mass term in the Lagrangian of such a particle is interpreted as the first Casimir operator of the $SU_3$ group, or, equivalently, as the Laplace operator in the group space of the group. The basic properties of Lie manifolds are derived; the existence of invariant differential forms is proved. The properties of the left and right invariant forms and of the structure constants are derived, as well as the relations between them. The Killing form is defined and the Lie derivative. These various properties are discussed for the $SU_2$ group, and the left and right invariant forms are explicitly calculated in Euler angle coordinates. The structure constants are found to be, as expected, $C^{D}_{AB} = \epsilon_{ABD}$, and all the basic theorems of Lie manifolds are verified for this particular case. The $SU_3$ group is discussed, particularly with regard to various possible coordinate systems. The usual coordinates of the exponential map are impractical for the consideration of finite transformations. A particular coordinate system is chosen that has the property that the derivatives, $dU/dx_i$, evaluated at the origin (the unit element), are just the Gell-Mann matrices, $\lambda_i$. The left invariant forms are explicitly calculated in these coordinates. The metric tensor of the manifold is discussed and explicitly calculated from the formula: $ds^2 = \mathrm{tr}\, dU \cdot dU^+$. This is shown to be equal, up to a constant factor, to the more usual expression in terms of the Killing form. Symmetry breaking is introduced by partially destroying the right invariance of the metric tensor. It is shown that if a Klein-Gordon type of operator is assumed to be the operator of mass squared in the manifold, the Gell-Mann-Okubo mass relation for the meson octet results. One introduces quark representations for the metric tensor, finds the irreducible parts, and assumes that the 27-component object is not present. The remaining vector part of the metric tensor is shown to be, as hoped, proportional to the hypercharge, and is shown to yield the correct mass relation. (Diss. Abstr. Int., B)

**21113** UNITARY IRREDUCIBLE REPRESENTATIONS OF SL(3,R) IN THE ALGEBRAIC APPROACH TO HADRONIC PHYSICS. Sijacki, D. Durham, NC; Duke Univ. (1974). 89p. University Microfilms Order No. 75-2424.

Thesis (Ph. D.).

The unitary irreducible representations of the SL(3,R) group are analyzed by means of the methods developed by Harish–Chandra and Kihlberg. Explicit closed expressions for the matrix elements of the noncompact generators for an arbitrary unitary representation of the SL(3,R) group were found. The irreducibility of the representations is achieved by using the little group technique and the scalar product for each irreducible Hilbert space is explicitly given. The relativistic extension of SL(3,R) is constructed and applied to hadronic physics. By the means of algebraic methods the model for the relativistic Regge sequences of hadrons is constructed. (Diss. Abstr. Int., B)

## Scattering Theory

*Refer also to abstract 21156.*

**21114** (COO-3235-46) COUPLED CHANNEL T OPERATOR FORMALISM AND FEDERBUSH DISEASE. Hahn, Y.; Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 10p. Dep. NTIS $4.00.

The coupled equations for n-body rearrangement collisions derived previously using the reduction method and the channel coupling array method are explicitly shown to be free of Federbush disease. (auth)

**21115** (COO-3235-47) GENERAL MANY-CHANNEL VARIATIONAL PRINCIPLES FOR MULTI-PARTICLE SCATTERING. Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 25p. Dep. NTIS $4.25.

A general multi-channel scattering formalism based on Schwinger-type variational principles and capable of treating rearrangements was recently presented by Tobocman. The approach involved combining variational functionals for individual transition operators with new coupled integral equations for these operators derived recently by Baer and Kouri and by Kouri and Levin. General variational principles are presented whose Euler equations are precisely the new coupled channel $T_{\alpha\beta}$ operator equations obtained by Kouri and Levin. The results are expressions which are stationary with respect to variations in all the $T_{\alpha\beta}$ simultaneously rather than just for a single $T_{\alpha\beta}$ operator. It is shown that such matrix generalizations may be obtained for a variety of functionals. With the specific choice of a channel permuting array (as discussed by Tobocman and by Kouri and Levin), the present formalism provides a valid computational basis for general many-body (e.g. nuclear) reactions, since then the iterated kernels of the resulting coupled channel $T_{\alpha\beta}$ operator equations are completely connected. (auth)

**21116** (COO-3235-48) UNITARITY IN NON-RELATIVISTIC, MANY-BODY SCATTERING. I. Post-Prior Formalism. Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 35p. Dep. NTIS $4.75.

The unitarity (discontinuity) equations first derived by Lovelace for the three-body problem are extended to the N-channel, n-body problem using the transition operators in the usual "post-prior," rearrangement scattering form. Specific enumeration of the arrangement channels and scattering states that actually enter the problem allow for a detailed expression of results heretofore implicit in other work. Two derivations are given, one based on use of the imaginary part of the full, outgoing-wave Green function, the other based on counting the contributions from the threshold discontinuities in the various arrangement channels. The consistency of these results is used as a means of deriving modified equations for the coupled channel T and K operators discussed previously. An important implication of the present results is that except by coincidence, approximated calculations of scattering amplitudes based on the "post" or "prior" transition operators cannot be unitary even if all open channels are included in the calculation except by coincidence. This conclusion explains the occurrence of previously obtained nonunitary amplitudes for $e^- + H$ scattering. (auth)

**21117** (COO-3235-49) UNITARITY IN NON-RELATIVISTIC, MANY-BODY SCATTERING. II. Modification of the Coupled Channel T and K Operator Equations. Kouri, D. J.; Levin, F. S. (Brown Univ., Providence, R. I. (USA). Dept. of Physics). 1974. Contract AT(11-1)-3235. 45p. Dep. NTIS $5.25.

The methods discussed previously for evaluating the discontinuity of the "post-prior" forms of the transition operators for multichannel, rearrangement scattering are applied to the new multichannel transition operators introduced recently by Kouri and Levin. This leads to important modifications in the integral equations obeyed by these latter transition operators, and also to the differential equations for the state vectors associated with them. An extremely simple model of identical particle scattering is introduced, and the symmetry of the problem is used to reduce the complexity of the equations describing the scattering. (auth)

**21118** (JINR-P2-8273) CONSIDERING OF THE INTERNAL LONGITUDINAL MOTION OF A COMPOSITE SYSTEM IN THE EIKONAL APPROXIMATION OF THE THREE-BODY RELATIVISTIC PROBLEM. Kvinikhidze, A. N.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An eikonal representation for the scattering amplitude on a composite system is obtained in which the internal longitudinal motion of the constituents is taken into account. (auth)

**21119** ON THE RELATION BETWEEN RESONANCES AND K-MATRIX POLES. Vitturi, A.; Zardi, F. (Padua Univ. (Italy). Istituto di Fisica). Z. Phys.; 269: No. 4, 333-338(Sep 1974). 8 figs.; 6 refs.

The relation between resonances and K-matrix poles for the potential scattering problem is investigated. The analysis is carried out in two stages. We first discuss the analytic properties of a K-matrix related to a model phase-shift which embodies the relevant features of a potential scattering resonance; we then consider the specific case of a square-well potential. The result emerging from the analysis is that to each resonance two poles of the K-matrix are associated; they appear either as a real resonance-echo pair or as a complex conjugate doublet, according to the value of a suitable background parameter. The relevance of this result in connection with the Huby theory is briefly discussed. (8 figures) (auth)

**21120** SIGN OF THE REAL PART OF THE ELASTIC FORWARD-SCATTERING AMPLITUDE AT HIGH ENERGIES. Cornille, H.; Hendrick, R.E. (Rockefeller University, New York, New York 10021). Phys. Rev. D 10: No. 11, 3805-3825 (1 Dec 1974).

For the reactions $a+b \to a+b$ and $a+\bar{b} \to a+\bar{b}$ we obtain some general results about the sign of the real part of the forward-scattering amplitude, taking into account some general experimental features of the total cross sections. These results give numerical bounds on the energy beyond which the real part must remain positive for various reactions, neglecting some low-energy effects. (i) For crossing-symmetric amplitudes, assuming that beyond the resonance region the symmetric total cross section decreases to a minimum, then increases, and remains a nondecreasing function of energy, we get a value of the energy beyond which the real part of the symmetric amplitude must remain positive. (ii) Assuming that the antisymmetric amplitude satisfies an unsubtracted dispersion relation and that the antisymmetric imaginary part does not change sign and is a nondecreasing function of energy, we find that the real part of the antisymmetric amplitude is always positive. (iii) We assume for the determination of the real part of $a+\bar{b} \to a+\bar{b}$ that (1) the antisymmetric amplitude satisfies an unsubtracted dispersion relation, (2) $E^{+1/2}\sigma^{A}$ does not change sign and does not decrease, or decreases under particular conditions to a constant, after some well-defined energy, (3) the total cross section for $a + b$ decreases to a minimum, then increases sufficiently and remains nondecreasing. Then, we determine the energy beyond which the real part of the forward antiparticle amplitude must be positive. Using the experiment data for $\sigma^{K^+p}_{tot}$ and $\sigma^{\bar{p}p}_{tot}$ from threshold up to the observed rise and low-energy data for the corresponding antisymmetric parts, we show that the real parts of the forward amplitudes for $K^-p \to K^-p$ and $p\bar{p} \to p\bar{p}$ must be positive at, and remain positive beyond, energies close to the minima of $\sigma^{K+p}_{tot}$ and $\sigma^{\bar{p}p}_{tot}$. (auth)

**21121** ASYMPTOTIC EQUALITY OF PARTICLE-ANTIPARTICLE DIFFERENTIAL CROSS SECTIONS AND OF SPACELIKE AND TIMELIKE FORM FACTORS. Grunberg, G.; Pham, T.N.; Truong, T.N. (Centre de Physique Théorique de l'Ecole Polytechnique, 17, rue Descartes, 75230 Paris Cedex 05, France). Phys. Rev. D 10: No. 11, 3829-3835 (1 Dec 1974).

A direct proof of the average asymptotic equality of particle and antiparticle differential cross sections and also of line-reversed processes is given without any restriction on the nature of oscillations. Using the same method, the average asymptotic equality of spacelike and timelike form factors is shown under some assumptions. As a consequence of the results proved, it is shown in general that if the ratios of the real part to the imaginary part of the forward amplitudes are bounded, the particle- antiparticle total cross sections must have asymptotically the same energy variation on the average. (auth)

**21122** STATIONARY-PHASE PRESCRIPTION AND SPECULAR REFLECTION IN HIGH-ENERGY POTENTIAL SCATTERING: FERMAT PRINCIPLE. Wu, A.C.T. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48104). Phys. Rev. D 10: No. 11, 3871-3873 (1 Dec 1974).

It is shown that in the Nth-order Born approximation of high-energy potential scattering the stationary phase prescription in the angular domain chooses those paths obeying the specular reflection at each step of a multiple scattering with an over-all scattering angle $\theta$. This is the generalized Reading-Bassichis theorem, or a restatement in Schrödinger theory of the familiar Fermat principle in geometrical optics. (auth)

**21123** SEMICLASSICAL MODEL FOR RISING CROSS SECTIONS. Carlitz, R. (The Enrico Fermi Institute and the Department of Physics, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 10: No. 11, 3878-3881 (1 Dec 1974).

The optical model is extended to incorporate diffractive excitations. The physical significance of cross sections rising indefinitely with energy becomes manifest in this model, and predictions result for various inclusive cross sections. These predictions are well in accord with existing data, and open new avenues of approach to problems such as the production of particles with large transverse momenta. (auth)

**21124** MOMENTUM EXPANSIONS OF LOOP GRAPHS AND THE EIKONAL APPROXIMATION. Dietz, K. (Physikalisches Institut der Universität Bonn, Bonn, West Germany). Phys. Rev. D 10: No. 11, 3796-3804 (1 Dec 1974).

A method for representing loop graphs as nonlocal n-particle couplings is described. An expansion in terms of soft momenta is then derived and used for the eikonalization of one-loop graphs. Loop contributions are shown to give considerable deviations from the Poisson distribution obtained in simple bremsstrahlung models. Average multiplicities and correlations are calculated. (auth)

**21125** DISPERSION SERIES FOR NONLOCAL POTENTIALS. Yao, T. H. (Bedford College, London). J. Math. Phys. (N. Y.); 16: No. 1, 68-71(Jan 1975).

For a class of short-range nonlocal potentials, and for the energy variable E in a certain part of the complex plane, a generalized subtracted dispersion relation is obtained which relates the forward scattering amplitude to contributions from negative energy pole terms, a usual dispersion integral along the positive real axis of the complex energy plane, and a uniformly convergent infinite series, apart from subtraction terms, subject to the condition that no bound state exists with energy less than $-\gamma^2$, where $\gamma$ is some parameter of the potential. (auth)

**21126** STIELTJES-INTEGRAL APPROXIMATIONS TO ELEMENTARY DISPERSION RELATIONS. Langhoff, P. W. (Indiana Univ., Bloomington). Int. J. Quant. Chem., Symp.; No. 8, 347-361 (1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Variational calculations in Hilbert space and theorems from the Tchebycheff-Stieltjes-Markoff moment theory are employed in the construction of Stieltjes-integral approximations to a number of elementary dispersion relations. Appropriate derivatives of the Stieltjes integrating functions provide convergent estimates for the absorptive and dispersive conjugate functions in their nonanalytic regions on the real axis, where the dispersion relations are of particular interest. Illustrative applications are given in the cases of the Kramers-Krönig-Heisenberg dispersion formula, the closely related wave number-dependent dielectric response function, a dispersion relation that arises in connection with lattice vibrations and the thermodynamic properties of crystals, and the Schwinger-Baker formula for the elastic-scattering Fredholm determinant. (auth)

**21127** EXACT ANALYTIC SOLUTIONS IN CONFIGURATION SPACE FOR SCATTERING WAVEFUNCTIONS AND T MATRICES FOR A CLASS OF SEPARABLE NONLOCAL POTENTIALS. Bagchi, B. Columbus, OH; Ohio State Univ. (1974). 114p. University Microfilms Order No. 75-3007.

Thesis (Ph. D.).

One considers scattering of all partial waves from a wide class of separable nonlocal potentials of rank N and exact analytic solutions are obtained for the real regular wave function and the phase shift in closed form. By an extension of the method the real irregular wave functions and Jost solutions are derived and applied to obtain expressions for equivalent local potentials following the method developed by Coz, Arnold and MacKellar. To facilitate the use of these potentials in many-particle calculations, one also derives the closed form expressions for the off-shell T matrices for the class of potentials. Finally, the special case of a potential of this class is considered as a fit to the $^1S_0$ n-p phase shift data and compare it with the Mongan Case IV potential. (Diss. Abstr. Int., B).

# PHYSICS (LOW-TEMPERATURE)

## Superfluidity

*Refer also to abstracts 20835 and 21107.*

**21128** EVIDENCE FOR UPWARD OR "ANOMALOUS" DISPERSION IN THE EXCITATION SPECTRUM OF He II. Dynes, R.C.; Narayanamurti, V. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. Lett. 33: No. 20, 1195-1197 (11 Nov 1974).

The dispersion and attenuation of superthermal phonons ($\hbar\omega > kT$) in He II at 0.1 K are remeasured and reinterpreted as a function of pressure. We find evidence for the existence of the three-phonon process and an upper energy cutoff to this process implying anomalous dispersion. Our earlier conclusion on the absence of anomalous dispersion at saturated vapor pressure is shown to be incorrect. (auth)

**21129** INSTABILITY OF A VORTEX ARRAY IN He II. Glaberson, W.I.; Johnson, W.W.; Ostermeier, R.M. (Department of Physics, Rutgers University, New Brunswick, New Jersey 08903). Phys. Rev. Lett. 33: No. 20, 1197-1200 (11 Nov 1974).

We propose an instability of a vortex array in the presence of axial normal-fluid flow in He II. This instability may be responsible for the influence of thermal counterflow on ion-trapping cross sections reported by Cheng, Cromar, and Donnelly. (auth)

**21130** SIZE EFFECTS IN SUPERFLUID EMISSION. McClintock, P. V. E.; Webster, A. G. (Univ. of Lancaster, Eng.). Cryogenics; 14: No. 12, 650-653(Dec 1974).

A detailed experimental investigation has been made of the influence of chamber dimensions on field emission characteristics in liquid $^4$He. The current was found to be a strong function of the emitter-collector separation, in satisfactory quantitative agreement with the predictions of a simple theory. (auth)

**21131** AMORPHOUS STATE MODEL FOR LIQUID HELIUM. Castaing, B. (Ecole Normale Superieure, Paris); Sawada, Y. J. Low Temp. Phys.; 18: No. 1-2, 159-167(Jan 1975).

In order to achieve a comprehensive model for the elementary excitations in liquid helium, the original cell model of Matsubara and Matsuda is modified. The lattice anisotropy is avoided, taking an amorphous arrangement for the sites, with fcc short-range order. The results are compared with the experimental data and the limitations of the model are examined. (auth)

**21132** EXPERIMENT ON THE BERNOULLI THINNING EFFECT IN UNSATURATED SUPERFLUID FILMS. Telschow, K. (Univ. of California, Los Angeles); Rudnick, I.; Wang, T. G. J. Low Temp. Phys.; 18: No. 1-2, 43-63(Jan 1975).

Measurements of the third-sound velocity on moving unsaturated superfluid films are presented in the range of 1.5 to 1.8 K. The results show that the average of the two Doppler-shifted velocities does not change with the film flow velocity. Since the third-sound velocity is highly thickness dependent, these results suggest that no thinning occurs in the moving film. An alternate possible interpretation is that the superfluid density may be velocity dependent. If this is the case, then this experiment presents measurements of this dependence. (auth)

**21133** HEAT CAPACITY STUDIES OF SUBMONOLAYER HELIUM FILMS ON GRAFOIL. Hering, S. V. Seattle; Univ. of Washington (1974). 84p. University Microfilms Order No. 75-3995.

Thesis (Ph. D.).

The heat capacity of submonolayer helium films adsorbed on a graphite substrate have been measured. For films of the $^3$He isotope, the study was made in a temperature range of .05 to 4 K for densities, n, of .0055 to .0220 and .070 to .092 particles per square Angstrom (at monolayer completion n = .110 Å$^{-2}$). At the highest densities, above .078 Å$^{-2}$, the heat capacity exhibits a group of phase transitions, analogous to those previously observed for $^4$He films, which are attributed to the melting of a two dimensional solid phase. For slightly lower film densities, n = .072 to .077 Å$^{-2}$ there is a sharp peak in the heat capacity just above 1 K. Measurements made here of the $^4$He isotope, from 1 to 4 K for n = .072 to .084 Å$^{-2}$, show a similar group of one degree transitions in the same density range. As with the lighter isotope, the melting line of $^4$He is also found to extend to a lower density of .078 Å$^{-2}$. No definite identification of the one degree transitions has yet been made, although several possibilities are discussed. Consideration is given to a two phase coexistence with the previously studied lower density ordered phase, and to the formation of an entirely new phase such as a substrate ordering, or two phase equilibrium independent of the lower density ordered phase. (Diss. Abstr. Int., B)

**21134** EFFECTIVE INTERACTION AND STATISTICAL MECHANICS IN THE PAIR THEORY OF LIQUID HELIUM. Yoon, S. Y. Eugene, OR; Univ. of Oregon (1974). 90p. University Microfilms Order No. 75-3935.

Thesis (Ph. D.).

The pair theory of liquid helium is discussed by assuming generalized Bose condensation. A variational method is formulated to determine the relationship between the effective interaction and the elementary excitation spectrum. The resulting system of nonlinear integral equations is solved self-consistently to obtain the effective potential from the experimental excitation spectrum. Contrary to the previous arguments, the potential is found to be strongly repulsive for this model. The temperature dependent problem is described by means of the thermodynamically equivalent Hamiltonian method. For the potential fixed with change in temperature, the temperature dependence of the excitation spectrum is investigated. The condensate fraction at zero temperature is 50% and decreases gradually as temperature increases up to a critical point. (Diss. Abstr. Int., B)

**21135** THEORY OF $^3$He ON FREE SURFACE OF SUPERFLUID $^4$He. Fu, H. H. Columbus, OH; Ohio State Univ. (1974). 124p. University Microfilms Order No. 75-3069.

Thesis (Ph. D.).

This dissertation describes the properties of $^3$He atoms on free surface of superfluid $^4$He. The existence of a bound state for one $^3$He atom on superfluid $^4$He free surface is examined. Using variational principle and density functional formalism, the shape of the surface, $^3$He effective potential, and surface binding energy have been determined. The binding energy and surface tension obtained are consistent with the experimental values. At temperatures much lower than the Fermi temperature, a collection of such bound $^3$He atoms may form a two-dimensional Fermi liquid. The static and kinetic properties of the Fermi liquid are studied. The interaction between surface $^3$He quasiparticles can be partially determined phenomenologically from measurements of surface second sound velocity and quasiparticle effective mass. From the interaction both the Fermi liquid transport coefficients and the transition temperature at which $^3$He becomes superfluid have been calculated. (Diss. Abstr. Int., B)

**21136** INFLUENCE OF THE SURFACE ON THIN SUPERFLUID $^4$He FILMS. Herb, J. A. Seattle; Univ. of Washington (1974). 96p. University Microfilms Order No. 75-3992.

Thesis (Ph. D.).

Two different techniques have been employed to study the onset of superfluidity in thin $He^4$ films. The results are qualitatively different from other onset measurements, the differences being attributed to the greater uniformity of the exfoliated graphite substrate used in the present study. The first experiment studies mass transport of $He^4$ films. Four distinct flow regimes are observed and are interpretated as being indicative of a more "ideal" film than previously reported. In the second section a model of surface heterogeneity is discussed and used to explain a variety of onset phenomena that have been observed in the past, but which are not understood. The model is applied to a current experiment; a frequency dependent onset temperature is predicted. Subsequent measurements showed that higher frequencies probed smaller regions of the substrate thus verifying the prediction. (Diss. Abstr. Int., B)

**21137** QUANTUM HYDRODYNAMICS OF A BOSE FLUID: AC JOSEPHSON EFFECT IN SUPERFLUID HELIUM. Biswas, A. C. (Tata Inst. of Fundamental Research, Bombay). J. Low Temp. Phys.; 18: No. 1-2, 3-11(Jan 1975).

An attempt is made to understand the ac Josephson effect in superfluid helium in terms of the quantum hydrodynamics developed by Biswas and Rao. The essential features of the new formalism are reviewed. It is shown that at absolute zero temperature the ac Josephson effect definitely exists in superfluid helium. However, at nonzero temperatures fluctuations in the system characteristic of the flow properties of liquid helium may make experimental observation of the effect extremely difficult. (auth)

**21138** BACKFLOW AND DENSITY EXCITATIONS IN QUANTUM FLUIDS. Wong, V. K. (Univ. of Michigan, Ann Arbor). J. Low Temp. Phys.; 18: No. 1-2, 65-84(Jan 1975).

By the use of the f sum rule and a separation of density excitations into single and multiple excitations, exact quantum expressions for the backflow contribution to the dynamic structure function $S(k,\omega)$ and for the discrete single-excitation spectrum $\omega_k$ are derived. The derivation is carried out for Bose liquids, Fermi liquids, charged quantum liquids, quantum solutions, an

impurity atom dissolved in quantum fluids, and phonons in solids. It is shown that the backflow arises from virtual multiexcitations and that real multiexcitations give rise to a background. It is argued that multiexcitations are relatively insensitive to long-range order or quantum statistics. Thus the backflow and background contributions to S(k, ω) of the liquid and solid phases of $^4$He, and also that to S(k) of liquid $^3$He and of liquid $^4$He, are expected to be similar, which is consistent with existing data. The exact expression for $\omega_k$, which shows that multiexcitations effectively repel the single excitations, is used to make some speculations concerning the large-wavevector phonon spectrum in liquid $^3$He and in $^3$He–$^4$He solutions. (auth)

**21139** PHONON SPECTRUM OF He II WITH HOMOGENEOUS MOMENTUM AND TEMPERATURE DEPENDENCE. Havlin, S.; Luban, M. (Bar-Ilan Univ., Ramat-Gan, Israel). J. Low Temp. Phys.; 18: No. 1-2, 95-100(Jan 1975).

The energy $\epsilon_p$ of a phonon in He II is found to have the form $\epsilon_p = c_0 p[1 + T^4 G(\eta)]$, $\eta = c_0 p/k_B T$. This result is obtained from a three-phonon renormalized Landau hydrodynamics model of the superfluid. How this form for $\epsilon_p$ resolves the apparent contradiction between several very recent experiments is shown. Also several results for the phase and group velocities and the low-temperature specific heat $C_v$ are shown which are direct consequences of the homogeneous form of $\epsilon_p$. (auth)

## Superconductivity

*Refer also to abstracts 20266, 20268, 20335, 20338, 20395, 20400, 20401, 20419, and 20427–20429.*

**21140** SUPERCONDUCTIVITY IN 1973. Matthias, B. T. (Univ. of California, San Diego, La Jolla). Int. J. Quant. Chem., Symp.; No. 8, 499-500(1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

Superconductivity is briefly reviewed including superconducting fluctuations, conductivities of crystals, raising of the superconducting transition temperature, and the nonsuperconducting behavior of copper, silver, and gold. (JFP)

**21141** RECOVERY CURRENT DENSITY OF HARD SUPERCONDUCTORS. Dew-Hughes, D. (Univ. of Lancaster, Eng.); Seshan, K.; Wallis, K. A. Cryogenics; 14: No. 12, 647-649(Dec 1974).

In order to quantify stability in superconductors, the power supplied as external heat to drive the superconductor normal was measured. At constant current and temperature, it was found that the conductor could not be driven normal below a certain critical field, and likewise at constant field there was a threshold critical current $1_t$. The threshold current density $J_t$ was found to correspond to the critical current density for the recovery of superconductivity after a disturbance, $J_r$. (auth)

**21142** FLUX FLOW EFFECTS IN A NEARLY REVERSIBLE TYPE II SUPERCONDUCTOR. de Lange, O. L.; Otter, F. A. Jr. (Clarkson Coll. of Tech., Potsdam, NY). J. Low Temp. Phys.; 18: No. 1-2, 31-42(Jan 1975).

Measurements of the Nernst effect over a wide range of magnetic field and temperature in a nearly reversible alloy ($Nb_{80}Mo_{20}$, $T_c = 4.15$ K, $\kappa \simeq 4.1$) are reported. Data are presented in the form of vortex transport entropy $S_d$ computed from the Nernst effect. At T = 3.5 K, values of $S_d$(Nernst) agree well with values of $S_d$ (Ettingshausen) for fields between about $2H_{c1}$ and $0.8H_{c2}$, in spite of the fact that pinning forces for current-induced motion exceed those for thermally induced motion by a factor of ten at this temperature. The measurements indicate that $S_d(B \simeq 0, T) > S_f(B \simeq 0, T)$ for $T \lesssim 0.63\ T_c$, where $S_f$ is the entropy of formation per vortex. Values of $S_d(0, T)$ are compared with low-field theory. The pinning forces are discussed in terms of surface pinning. (auth)

**21143** PHASE COHERENCE IN TWO-BAND SUPERCONDUCTORS. Rogovin, D. (Univ. of Arizona, Tucson). J. Low Temp. Phys.; 18: No. 1-2, 1-2(Jan 1975).

The existence of possible phase coherence phenomena in two-band superconductors is discussed. (auth)

**21144** CRITICAL TEMPERATURE OF TWO-BAND SUPERCONDUCTORS AND PARAMAGNETIC IMPURITIES. Will, P.; Brusberg, M. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). J. Low Temp. Phys.; 18: No. 1-2, 169-181(Jan 1975).

The two-band model proposed by Suhl, Matthias, and Walker for pure transition metal superconductors is extended to transition metals with paramagnetic impurities under the assumption that the cutoff parameters $\omega_{ij}$ (i, j = s, d) of the pairing interactions between electrons $V_{ij}$ are different from each other. An equation is derived for the critical temperature $T_c$. In the dilute limit $T_c(n)$ can increase with impurity concentration n only for $\omega_{ss} \neq \omega_{sd}$, $\omega_{dd} \neq \omega_{sd}$. In the one-band limit the results reduce to those of Abrikosov and Gor'kov. The theoretical function $T_c(n)$ is used to fit the experimental data for the alloys $La_{1-n}Ce_n$ and $Ce_{1-n}Nd_nRu_2$. The agreement of the theoretical $T_c(n)$ curve with the experimental points is good, with the exception of $La_{1-n}Ce_n$ for values n near the critical concentration $n_c$, where stronger deviations appear as a consequence of magnetic ordering. (auth)

# PHYSICS (NUCLEAR)

## Neutron Interactions with Matter

*Refer also to abstract 21164.*

**21145** (CEA-R-4597) DETERMINATION OF THERMAL AND EPITHERMAL NEUTRON FLUX AT THE CENTER OF A POLYETHYLENE SPHERE IRRADIATED BY NEUTRONS BETWEEN 10 eV AND 14 MeV: DOSIMETRY APPLICATIONS. Lymberis, C. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Protection et des Etudes d'Environment). Dec 1974. 71p. (In French). Dep. NTIS (US Sales Only) $6.75.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble, France.

This note describes the calculations made to obtain the neutron spectrum at the center of a moderating sphere irradiated by monoenergetic neutrons between 10 eV and 14 MeV. The sensitivity for detection is calculated when a detector for epithermal neutrons is placed at the center of the sphere. Also calculated is the variation of sensitivity of detection versus neutron energy for a given diameter of sphere when an epithermal detector is used at a center in place of the thermal-neutron detectors. Experiments with 14-MeV and 3-MeV neutrons were done to confirm the calculations. (34 figures, 22 tables) (auth)

**21146** (IAE-2324) PROGRAM COMPLEX FOR CALCULATING SPACE-ENERGY AND ANGULAR DISTRIBUTION OF THERMAL NEUTRONS IN FLAT INHOMOGENOUS SYSTEMS "DEMETRA-1". Pt. 1. Lyashenko, G. V.; Safin, Yu. A.; Trukhanov, G. Ya. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1973. 19p. (In Russian). INIS.

The purpose of this study was the creation of a program which calculates the angular distribution of thermal neutrons in plane, inhomogeneous media. The complex of programs "DEMETRA" was taken as a basis, where solution of the multi-velocity kinetic equation of neutron transport is carried out for a one-dimensional, multi-zone cell of a hetereogeneous reactor by the quasidiffusion method of V. Gol'din on the basis of convergence of an integral kernel proposed in the study. By reason of organization features of the complex of programs "DEMETRA" it is possible to introduce into the complex a program of calculating the vector neutron flux and a number of accessory programs organizing the process of calculation without changing the calculation algorithm of the remaining programs. The complex of programs calculating the space-energy and angular distribution of thermal neutrons in plane inhomogeneous systems acquired the name "DEMETRA-1". In addition to the programs of the main complex "DEMETRA" the following programs enter into the complex: "VEKTOR"–"000014"; "VP-3"–"000011"; "VP-4"–"000012"; "VP-5"–"000013". These programs, as the programs of the complex "DEMETRA", are written in ALGOL-60 language, more precisely, in its dialect-exit language to translator TA-2M. The capabilities of the program are: total number of zones in a cell $N_z \leq 30$; the number of these zones of different kinds $N_k \leq 8$; number of velocity groups $N_v \leq 20$ (the group width $\Delta v$ in the framework of a given variant should be taken as constant); number of points of the space mesh $N_{int} \leq 100$ (the mesh step can be arbitrary). This study gives a short presentation on calculating with the complex of programs "DEMETRA-1". A description is given on preparing the initial data to be introduced into the program, withdrawing intermediate values and final results, and also preparing the complex "DEMETRA-1" for operation (for users of the M-220 computer). A control text is presented. Texts are given in ALGOL-60 language for new programs of the complex as "VEKTOR", "VP-3", "VP-4", "VP-5" and those programs of the complex "DEMETRA", in which a number of changes have been introduced. (tr-auth)

**21147** (Y-1959) NEUTRON IMPORTANCE AND FISSION DENSITY IN ENRICHED URANIUM AND PLUTONIUM METAL SPHERES. Mihalczo, J. T. (Oak Ridge Y-12 Plant, Tenn. (USA)). 16 Jan 1975. Contract W-7405-eng-26. 42p. Dep. NTIS $4.00.

Spatial distribution of the neutron importance in bare and natural-uranium-reflected uranium (~93.2 wt % $^{235}$U) and plutonium (~4.8 at. % $^{240}$Pu) metal spheres was measured by using $^{252}$Cf neutron sources. Spatial distribution of the fission density from activation measurements in the bare spheres and those previously measured for the reflected spheres are presented. Comparison of these distributions with those from $S_{16}$ transport theory calculations showed that the measured and calculated results agreed very well for the bare spheres and in the central core of the reflected spheres. Disagreement in the natural uranium reflector increased with radius and obtained values as large as ~40% at the outer surface. An analysis of the sensitivity of the calculations to the cross sections and the nuclear temperature of the fission spectrum was performed. These measurements were undertaken to account properly for spatial effects in the point-reactor kinetics description of Rossi-$\alpha$ measurements. The spatial effects factors obtained from these measurements, which multiply the correlated amplitude of the Rossi-$\alpha$ measurement, were 1.123, 1.109, 1.163, and 1.214 for the bare uranium, bare plutonium, reflected uranium, and reflected plutonium spheres, respectively. The error in these values was ±0.010. (18 figures, 11 tables) (auth)

**21148** COLD NEUTRON SCATTERING FROM GASEOUS METHYL HALIDES. Malm, W. C.; Danner, H. R.; Lurie, N. A. (Univ. of Missouri, Columbia). J. Chem. Phys.; 61: No. 9, 3863-3864(1 Nov 1974).

The full cold spectrum transmitted by a refrigerated Be filter was incident on the sample. Analysis of the results was by Fermi chopper. Experimental and theoretical curves as derived from the Gaussian formalism of Agrawal and Yip [Phys. Rev., 171, 263 (1968)] are shown for $CH_3I$, $CH_3Cl$, and $CH_3F$. The Gaussian formalism described the differential scattering cross sections from the methyl halide gases reasonably well. (1 figure) (RWR)

**21149** APPLICATION OF INVARIANT IMBEDDING IN CALCULATIONS OF NEUTRON TRANSPORT THROUGH SEMI-THICK $H_2O$ LAYERS. Jambor, J. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 53-58(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The application of the invariant imbedding method in thermalization calculations (slab geometry) is described. The basic equations of the method expressing the functions of scattering and transmission for the isotropic, separated kernel are listed. Numerical results obtained using this method are discussed, namely scattering and transmission functions for $H_2O$ layers of various thickness, applying the Corngold approximation of the scatter kernel. (auth)

## Nuclear Properties and Reactions, A ≤ 5

*Refer also to abstracts 20936, 21095, 21209, and 21247.*

**21150** (HU-TFT-74-13) EFFECT OF THE $\Delta(1236)$ ON THE TRINUCLEON CHARGE FORM FACTOR. Green, A. M.; Kallio, A. J.; Toropainen, P.; Kouki, T. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics; Oulu Univ. (Finland). Dept. of Theoretical Physics). 1974. 15p. (CONF-740575-1). Dep. NTIS (US Sales Only) $4.00.

From symposium on the theory of lightest nuclei; Liblice, Czechoslovakia (29 May 1974).

The $\Delta(1236)$ is introduced into the wave functions of $^3$He and $^3$H and the charge form factor calculated. The effect is to slightly aggravate the already large discrepancy between theory and experiment for $q^2 \gtrsim 14$ fm$^{-2}$. However, there are two side benefits–a simple way to understand the d-wave contribution to the CFF, and a simple N$\Delta$ correlation function having a very good overlap with a more exact correlation. (auth)

**21151** (JINR-E4-8284) ON THE CALCULATION OF THE ELASTIC AND INELASTIC PROTON–DEUTERON SCATTERING. Moeller, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 27p. Dep. NTIS (US Sales Only) $4.50.

A concise scheme is given for the calculation of the cross sections for elastic and inelastic proton–deuteron scattering starting from a given two-body local potential. The integral equations for the three-body amplitudes are represented in terms of graphs. The given scheme is applied to calculate the first two terms of the multiple scattering series (pole and square graph) in linear effective range approximation. (5 figures) (auth)

**21152** (JINR-P1-8328) ENERGY DEPENDENT PHASE SHIFT ANALYSIS OF $\pi^+$ He$^4$ ELASTIC SCATTERING. Aleksandrov, L.; Angelesku, T.; Nikitiu, F.; Falomkin, I. V.; Shcherbakov,

Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 12p. (In Russian). (CONF-740822-9). Dep. NTIS (US Sales Only) $4.00.

From conference on few-body problems in nuclear and particle physics; Quebec, Canada (27 Aug 1974).

An energy-dependent phase-shift analysis of elastic $\pi^{\pm}$He$^4$ scattering is presented for the energy interval from 24 MeV to 180 MeV (all existing data on differential and total cross sections). Using the idea of quasipotential equations were obtained for scattering amplitudes with relativistic kinematics. Prior to the energy-dependence phase-shift analysis a fit of all single-energy solutions was made to test different forms for energy behavior of partial wave amplitudes. This analysis was repeated including high partial wave amplitudes taken from ACE analysis and the new experimental data on total cross section. The least $\chi^2$ per data point and least number of free parameters are reached. For $\chi$-squared minimization a new algorithm was used for solving nonlinear systems of equations which is based on the regularized iteration processes of the Gauss–Newton type. The total number of free parameters was 51 for 393 data points (16 normalization parameters). The $\chi^2/N_p$ was ~2.2 (all points) and 1.25 for a fit without 28 points (with $\chi^2 \geq 8$). The results are shown $\delta_l$ and $\eta_l$ for S, P, and D waves together with energy-independent phase-shift results and in an Argand plot. The total and elastic cross sections are shown. The resonant behavior of the P, D, F and G waves is demonstrated by the velocity diagram of the Argand vector ($|df_l/dT|$). The smallest non-resonant background is in the P wave for which the partial total and elastic cross section has a clear Breit–Wigner behavior. Taking into account different tests for resonant behavior of partial waves it is possible to suggest a strong $\pi$He$^4$ resonance in the P wave at a pion kinetic energy of 80 to 125 MeV. The Ref(0) is shown (the dashed region is the error corridor); there are also shown dispersion relations calculation (curve a) and finite sum-rule results. The S wave scattering length is $a_0 = -0.16 \pm 0.01 + i(0.055 \pm 0.007)$ fm, and the electromagnetic pion radius obtained from the analysis, using a previous method, is $\langle r_\pi^2 \rangle^{1/2} = 0.83 \pm 0.17$ fm. (auth)

**21153** (LA-5828-MS) T(d,n)$^4$He AND T(t,2n) CROSS SECTIONS AT LOW ENERGIES. Stewart, L.; Hale, G. M. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1975. Contract W-7405-eng-36. 15p. (USNDC-CTR-2). Dep. NTIS $4.00.

The present status of the T(d,n)$^4$He and T(t,2n)$^4$He cross sections is reviewed for incident-particle energies below 1 MeV. Parameterizations of the T(d,n) cross section in this energy region are discussed along with predictions from a preliminary, but comprehensive, R-matrix analysis of reactions in the five-nucleon system at low energies. Tabular values of these predictions are given at energies between 5 keV and 1 MeV. (8 figures, 2 tables) (auth)

**21154** (ZFK-271, pp 21-31) LEVEL DENSITY OF LIGHT EVEN–EVEN NUCLEI IN THE SUPERFLUID MODEL OF THE NUCLEUS. Ignatyuk, A. V.; Sokolov, Yu. V.; Shubin, Yu. N. (Physics-Energy Inst., Obninsk, USSR). Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

An analysis of available experimental data on the density of excited states of light ($A < 70$) even-even nuclei was made in the framework of the superfluid model of the nucleus. The effect of the shell structure on the behavior of the level density was studied. The calculations made showed that on the basis of this model the experimental data on the level density is satisfactorily described for a large number of light even-even nuclei in a wide interval of excitation energies. (tr-auth)

**21155** VECTOR ANALYZING POWER IN d–p SCATTERING AT 45.4 MeV AND THE NUCLEON–NUCLEON INTERACTION. Rad, F.N.; Birchall, J.; Conzett, H.E.; Chintalapudi, S.; Roy, R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 33: No. 20, 1227-1229 (11 Nov 1974).

The deuteron vector analyzing power in deuteron–proton elastic scattering has been measured at $E_d$=45.4 MeV. Our results, when compared with recent three–body calculations, suggest the possibility of deducing information on the n–p phase–shift parameters which has not been available from n–p scattering itself. (auth)

**21156** FINITE-RANK POTENTIALS WITH COULOMB INTERACTIONS. Cattapan, G.; Pisent, G. (Univ., Padua). Lett. Nuovo Cim.; 11: No. 15, 650-654(14 Dec 1974).

A general formal procedure is developed by which Coulomb effects may be incorporated in an exact and systematic way into the structure of the two-body scattering problem for finite-rank potentials. In the momentum space representation the general formalism reproduces some specific results obtained earlier. It is shown how the nuclear phase shifts and transition matrix elements may be obtained. (JFP)

**21157** WHAT CAN WE LEARN FROM THREE–BODY REACTIONS? Haftel, M. I.; Petersen, E. L. (Naval Research Laboratory, Washington, D. C. 20375). Phys. Rev. Lett. 33: No. 20, 1229-1232 (11 Nov 1974).

Deuteron–breakup calculations are performed by using phase–equivalent potentials that differ off shell with and without the constraint of a fixed triton binding energy. This approach is compared with the previous work of Brayshaw. We examine various regions of phase space and energy between 14 and 65 MeV. Our results show that new off–shell information can be obtained from deuteron–breakup studies in the final–state region of phase space. (auth)

**21158** WHERE DOES THE LOCAL-POTENTIAL MODEL DIFFER FROM THE H(d,2p)n DATA AT $E_d$ = 26.5 MeV. Wielinga, B. J. (Inst. for Nuclear Physics Research, Amsterdam); Balder, J. R.; Van Dantzig, R.; Slaus, I.; Kloet, W. M.; Tjon, J. A. Lett. Nuovo Cim.; 11: No. 15, 655-658(14 Dec 1974).

Some data on the H(d,pp)n reaction at 26.5 MeV are presented. Differential breakup cross sections are shown as a function of the neutron center-of-mass angle. (JFP)

**21159** ELASTIC AND INELASTIC PION–NUCLEUS SCATTERING. Hess, A. T. Charlottesville, VA; Univ. of Virginia (1974). 189p. University Microfilms Order No. 74-29,214.

Thesis (Ph. D.).

The elastic and, especially, the inelastic scattering of pions from various nuclei were considered in order to attempt to extract nuclear structure information and to test several theories of the reaction mechanisms. The results of three calculations are given: total cross sections for the ($\pi^+$,$\pi^-$) charge exchange process in $^{12}$C and $^{91}$Zr calculated using the distorted wave impulse approximation (DWIA) formalism. The distortion effects on the pion waves were handled by the use of an appropriate pion-nucleus optical potential. The reaction is one which may be able to probe the difference between neutron and proton distributions in nuclei. For several reasonable choices for this difference, the total cross sections all show a minimum at the approximate position of the 3,3 resonance. Comparisons of results with experiment and other calculations are presented. Inelastic pion scattering was examined using the DWIA formalism. Differential cross sections were calculated for exciting various levels in a wide range of nuclei. The excited states were described by a one-particle/one-hole model. In particular, the excitation of giant resonances was studied, as well as transitions to surface vibrational states. For those levels where data exist comparison with experiment is presented. Finally, differential cross sections were calculated for pions elastically scattered from $^4$He and $^{12}$C using the Glauber multiple-scattering formalism. The high-energy approximations used in deriving the Glauber theory would seem to preclude its use in the 3,3 resonance energy region. However, for reasons not fully understood, the theory seems to work well there. In the calculations, scattering was examined at energies at and below the resonance in order to determine the effects of the explicit inclusion of spin and isospin degrees of freedom on the differential cross section. Comparison with experiment for $\pi^-$–$^{12}$C scattering shows the theory to break down for pion energies below 120 MeV for both the inclusion and exclusion of spin and isospin degrees of freedom. (Diss. Abstr. In., B)

**21160** A-G-S FORMALISM OF THE FOUR–NUCLEON SYSTEM. Erens, G. (Univ. of South Africa, Pretoria). pp A1-A11 of Eighth Annual Seminar on Theoretical Physics. Pretoria; Univ. of South Africa (1973).

From 8th annual seminar on theoretical physics; Pretoria, South Africa (9 Jul 1973).

The formalism of Alt, Grassberger and Sandhas for the four-nucleon system is derived, and it is shown, following Sandhas's treatment, that these equations can be presented in the same algebraic form as the corresponding two- and three-body equations. This result can in principle be extended to the n-body system. (INIS)

## Nuclear Properties and Reactions, 6 ≤ A ≤ 19

*Refer also to abstracts 21089, 21091, 21154, 21159, 21188, 21197, 21209, 21247, 21249, and 21269.*

**21161** (INIS-mf-1280) RESONANCE IN ELASTIC DISPERSION OF PARTICLES WITH SPIN ½ AND SPIN ZERO. Ulloa L,

N.Y. (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1973. 61p. (In Spanish). INIS.
Thesis.
The ($J^\pi$) parameters of some easily obtained resonances of the elastic reactions $^{16}O(p,p)^{16}O$, $^{28}Si(p,p)^{28}Si$, and $^{24}Mg(p,p)^{24}Mg$ were studied in the energy region of 0 to 5 MeV by use of a graphic method in which the amplitude and phase of each partial wave is represented as the components of a vector in the complex plane. The study was made with a computational program developed for this purpose. (tr-auth)

**21162** (JINR-1-7653) $^2H$, $^3H$, $^3He$, AND $^4He$ ISOTOPE PRODUCTION IN THE p + $^{12}C$ REACTIONS WITH THE 660 MeV PROTON ENERGY. Bogatin, V. I.; Vikhrov, A. I.; Grigorev, E. L.; Lozhkin, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 22p. (In Russian). INIS.
An experimental study was made of the kinematic characteristics of isotopes of H and He during inelastic interaction of 660-MeV protons with carbon nuclei using dE/dx and E detectors. (tr-auth)

**21163** (LUNP-7412) REACTION $^{11}B(\gamma,p)^{10}Be^*$ INTERMEDIATE ENERGIES. Adler, J. O.; Jonsson, G. G.; Lindgren, K. (Lund Univ. (Sweden). Fysiska Institutionen). May 1974. 10p. INIS.
The number of nucleons available for the $^{11}B(\gamma,p)^{10}Be^*$-reaction was measured in the pion resonance region by observing deexcitation gamma rays. The experimental value is compared to theoretical predictions for proton pickup on $^{11}B$. (auth)

**21164** (WANL-TME-1025) BERYLLIUM (n,2n) CROSS SECTION: CALCULATION OF RESULTANT NEUTRON ENERGY SPECTRUM FOR GAM PROGRAM. Gibson, G.; Melnick, M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 5 Feb 1965. 15p. Dep. NTIS $4.00.
The GAM group energy spectrum of the neutrons resulting from the Be(n,2n) reaction was obtained. The treatment is divided into two sections: incident neutron energies in excess of 2.7 MeV (great enough to excite the Be 2.43-MeV level) and incident neutron energies less than 2.7 MeV. Detailed equations are presented. A program was set up to solve the equations, and the calculations were carried out for incident neutron energies in the first seven GAM groups (1.74 to 10 MeV) and resultant neutron energies in the first thirty GAM groups (5.53 keV to 10 MeV). The sum of the probabilities for finding a neutron in the various GAM groups for an incident neutron energy in a particular GAM group totaled one in each case. The partial Be(n,2n) cross sections for creating a neutron in a particular GAM group are tabulated. (3 figures, 1 table) (RWR)

**21165** (ZFK-271, pp 112-114) ANGULAR DISTRIBUTION OF $\alpha$-PARTICLES FROM THE $^9Be(n,\alpha_0)^6He$ REACTION INDUCED BY 14.1-MeV. Burzynski, S.; Smolec, W.; Turkiewicz, I. M.; Turkiewicz, J.; Zupranski, P.; Rusek, K. (Inst. of Nuclear Research, Warsaw). Feb 1974.
From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).
In proceedings of the third international seminar on interactions of fast neutrons with nuclei.
Evidence of the mechanism of heavy particles stripping with the beryllium-9 nucleus, assumed to have helium-5 + alpha cluster structure, was found from the angular distributions of alpha particles from the $^9Be(n,\alpha_0)^6He$ at 14.1 MeV. (JFP)

**21166** (ZFK-271, pp 115-118) NEUTRON INDUCED REACTIONS ON LIGHT NUCLEI WITH THREE AND FOUR PARTICLES IN THE FINAL STATE. Turk, M.; Antolkovic, B.; Dolenc, Z.; Winterhalter, D. (Inst. Rudjer Boskovic, Zagreb). Feb 1974.
From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).
In proceedings of the third international seminar on interactions of fast neutrons with nuclei.
Multiparticle neutron reactions on lithium-7, boron-10, carbon-12, nitrogen-14 were studied by the nuclear emulsion technique at 14.4 and 18.2 MeV. The spectra, total cross sections, and energy levels are discussed. (JFP)

**21167** PION PRODUCTION ON $^{10}B$ BY 185 MeV PROTONS. Dahlgren, S.; Grafstroem, P. (Uppsala Univ.). Phys. Scr.; 10: No. 3, 104-106(Sep 1974).
Energy spectra of pions produced in the reaction $^{10}B(p,\pi^+)^{11}B$ at $E_p$ = 185 MeV were measured in the angular range 20 to 130° (lab.). Angular distributions for proton capture to the ground state and first excited state in $^{11}B$ were determined. An attempt to observe the T = 3/2 analog states in $^{11}B$ and $^{11}N$ was made but did not succeed. (auth)

**21168** INVESTIGATION OF THE LOW LYING LEVELS IN $^9B$. Cheng Ming Fou; Gagne, R. M. (Delaware Univ., Newark (USA). Dept. of Physics). Z. Phys.; 267: No. 5, 331-336(May 1974).
8 figs., 11 refs.
The reaction $^{10}B(^3He,\alpha)^9B(p)^8Be(g.s.)$ has been studied using a 1.8 MeV $^3He^+$ beam. Coincidence spectra were measured at $\theta_\alpha$ = −150° and $\theta_p$ = 22.5°, 30°, 37.5°, 45°, 52.5°, 60° and 67.5° for the identification of the levels in $^9B$ which decay by proton emission. Possible new excited levels in $^9B$ were observed at (1.9 ± 0.1), (2.1 ± 0.1), (2.6 ± 0.1) and (3.1 ± 0.1) MeV. (8 figures) (auth)

**21169** PROTON INELASTIC SCATTERING TO DIPOLE STATES OF $^{12}C$ AND ISOVECTOR COLLECTIVE MODELS. Buenerd, M.; de Saintignon, P.; Martin, P.; Loiseaux, J.M. (Institut des Sciences Nucléaires, 38044 Grenoble−Cedex, Grenoble, France). Phys. Rev. Lett. 33: No. 20, 1233-1236 (11 Nov 1974).
The dipole strength has been measured in $^{12}C$ between 22− and 27−MeV excitation energy by inelastic scattering of 45− and 155−MeV protons. The dipole cross section is compared to the results of isovector−collective−model, distorted−wave Born−approximation calculations and to photonuclear experimental results. (auth)

**21170** ABSOLUTE DIFFERENTIAL CROSS-SECTION OF THE $^{10}B(d,\alpha)^8Be$ REACTIONS AT $E_d$ = 1.83 MeV. Lattuada, M.; Potenza, R. (Univ., Catania, Italy). Lett. Nuovo Cim.; 11: No. 15, 662-664(14 Dec 1974).
The differential cross sections of the $^{10}B(d,\alpha_0)^8Be$ and $^{10}B(d,\alpha)^8Be^*$ processes were studied at 1.83 MeV. It was concluded that the data are compatible with the presence at backward angles of heavy-particle stripping with l = 2. It is noted that these results are useful for the analysis of data obtained from the bidimensional spectra or as auxiliary information about the reaction mechanism. (JFP)

**21171** THEORETICAL ANALYSIS OF POSITIVE PION PRODUCTION ON $^{12}C$ BY 185 MeV PROTONS. Hoeistad, B.; Dahlgren, S.; Grafstroem, P.; Aasberg, A. (Uppsala Univ.). Phys. Scr.; 9: No. 4, 201-207(Apr 1974).
Calculations of positive pion production on $^{12}C$ leading to the $1p_{\frac{1}{2}}$, $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ states in $^{13}C$ are performed in a one-nucleon reaction model. Distorted waves are used to describe the proton and the pion. A certain agreement is found with experimental data. The choice of pion-nucleus optical potential is crucial for the result of the calculations. (auth)

**21172** K-ELECTRON SHAKE-OFF IN BETA-DECAY. Law, J.; Cambell, J. L. (Univ. of Guelph, Ont.). Lett. Nuovo Cim.; 11: No. 16, 676-678(21 Dec 1974).
The probability of creating a K vacancy per beta decay is calculated for helium-6, phosphorus-32, nickel-63, palladium-107, indium-114, samarium-151, mercury-203, and thallium-204. (JFP)

**21173** STRUCTURE OF T = 0 STATES IN $^{16}O$. Suzuki, Y.; Ikeda, K. (Niigata Univ., Japan). Progr. Theor. Phys. (Kyoto); 51: No. 5, 1621-1623(May 1974).
It is shown that the resonating group approach of carbon-12 + $\alpha$ is promising as a unified model for T = 0 low lying states, by presenting a result based on the orthogonality condition model. The wave function of carbon-12 is assumed to be of 0(4) of SU(3) and the Pauli principle between carbon-12 and $\alpha$ is taken into account according to the orthogonality condition model. (JFP)

**21174** PHOTOPROTON SPECTRUM FROM CARBON WITH GOOD ENERGY RESOLUTION. Wienhard, K.; Bangert, K.; Stock, R.; Wolf, H. (Giessen Univ. (F.R. Germany). Inst. fuer Kernphysik). Z. Phys.; 270: No. 2, 93-95(Oct 1974).
2 figs., 10 refs.
The 90° photoproton spectrum from $^{12}C$ has been measured with good energy resolution by using bremsstrahlung with maximum energy Eγ = 31 MeV. A fragmentation of the giant dipole resonance in fine structures with a typical width of 150 to 300 keV is observed. (auth)

**21175** MEASUREMENT OF $\pi^\pm$ TOTAL CROSS SECTIONS ON $^3He$, $^9Be$, AND $^{12}C$ OVER THE 3/2, 3/2 RESONANCE REGION. Spence, C. B. Jr. Williamsburg, VA; Coll. of William and Mary (1974). 145p. University Microfilms Order No. 75-4661.
Thesis (Ph. D.).
A transmission experiment was performed in which total cross sections for $\pi^+$ and $\pi^-$ on $^3He$, $^9Be$ and $^{12}C$ were obtained for several energies between 100 and 250 MeV. The $^3He$ and $^9Be$ cross sections were used in the evaluation of the Kim and Primakoff sum rule for nuclear beta decay. The evaluation of the sum rule is further extended to $^7Li$ cross sections obtained by Allardyce et al. A second application of the $^3He$ data is made to determine a value for the effective $\pi$-nucleus coupling constant, $r_{eff}$. This is generated from a dispersion relation calculation, and is found to be $r_{eff}$ ($^3He$) =

0.071 ± 0.012, which compares to a value of 0.081 ± 0.002 for the nucleon. Finally the $^3$He data are compared to the results of a Glauber-like total cross section calculation by Gurvitz. (Diss. Abstr. Int., B)

**21176** $^{12}C(\gamma,p)$ REACTION AT $E_\gamma$ = 60, 80, AND 100 MeV. Findlay, D. J. S.; Gardiner, S. N.; Matthews, J. L.; Owens, R. O. (Univ. of Glasgow). J. Phys., A (London); 7: No. 16, L157-L160 (1 Nov 1974).

The angular distribution of the $^{12}C(\gamma,p)$ reaction has been measured at $E_\gamma$ = 60, 80 and 100 MeV for excitation energies 0 to 7 MeV in the residual nucleus. The measured cross sections are considerably larger than IPM predictions and are compared with a calculation which uses a Jastrow correlation factor to simulate the effect of two-nucleon interactions. (auth)

**21177** STUDY OF ($^7$Li,t) REACTIONS ON LIGHT NUCLEI. Cobern, M. E. New Haven; Yale Univ. (1974). 169p. University Microfilms Order No. 75-1345.

Thesis (Ph. D.).

Triton angular distributions were measured from the ($^7$Li,t) reactions on targets of carbon-12, nitrogen-14, oxygen-16, and neon-20 at lithium beam energies from 36 to 40 MeV in the laboratory. These reactions selectively populate a small number of states at forward angles, and the angular distributions of these states are primarily forward-peaked. An exact finite-range coupled-channels DWBA code was used to analyze the angular distributions of tritons populating the three lowest members of the 4p–4h ($K^\pi = 0^+$) band in oxygen and the first three members of the ground-state ($K^\pi = 0^+$) band in neon-20. Alpha-particle reduced widths were extracted for these states. A Hauser–Feshbach analysis indicated that for those states selectively excited at forward angles the reaction mechanism is primarily compound-nuclear in nature at angles >90° (c.m.). Angular distributions were also extracted for a number of other states not strongly excited at forward angles; these states appear to be populated almost entirely via compound-nucleus formation at all angles. A qualitative analysis of the angular distributions for the $^{14}N(^7Li,t)^{18}F$ reaction showed that the two states at 9.472 and 11.074 MeV are probably members of the $K^\pi = 1^+$ band of fluorine-18, which dominates the forward-angle spectra. Angular distributions for lithium elastic scattering from targets of carbon-12, nitrogen-14 and neon-20 were measured at a beam energy of 36 MeV. Optical potential parameters were determined. (Diss. Abstr. Int., B)

**21178** MEASUREMENTS AND HAUSER–FESHBACH ANALYSIS OF THE $^{19}B(^{16}O,^6Li)^{29}Ne$ REACTION. Ford, J. L. C. Jr.; Robinson, R. L.; Stelson, P. H. (Oak Ridge National Lab., Tenn. (USA)); Thornton, S. T. (Virginia Univ., Charlottesville (USA). Dept. of Physics); Campo, J. G. del (Universidad Nacional Autonoma de Mexico, Mexico City. Instituto de Fisicca). Z. Phys.; 269: No. 2, 147-153(1974).

States in $^{20}$Ne were populated by the $^{19}B(^{16}O,^6Li)$ reaction, and levels were observed up to 11 MeV in excitation energy. Cross sections were measured at 7°(lab) for bombarding energies from 44.4 to 46 MeV in 400 keV intervals. The reaction appears to be predominantly due to compound-nucleus formation, and good agreement was found between the measured cross sections and Hauser–Feshbach calculations, assuming the known spin values of $^{20}$Ne. (auth)

**21179** PRECISION MEASUREMENTS OF THE NUCLEAR MAGNETIC DIPOLE MOMENTS OF $^6$Li, $^7$Li, $^{23}$Na, $^{39}$K AND $^{41}$K. Beckmann, A.; Boeklen, K. D.; Elke, D. (Bonn Univ. (F. R. Germany). Inst. fuer Angewandte Physik). Z. Phys.; 270: No. 3, 173-186(Oct 1974).

By using the atomic beam magnetic resonance method and using the technique of separated oscillatory fields in combination with the triple resonance method, the ratios $g_I/s_I$ of the stable alkali isotopes Li, Na and K in the $^2S_{\frac{1}{2}}$ ground state have been measured at magnetic fields of about 3 kOe. Furthermore, the hyperfine structure splitting constants in the $^2S_{\frac{1}{2}}$ ground states have been determined. By using the most precise absolute $g_I$ values available so far, one can calculate absolute values for the uncorrected $g_I$ factors. By comparing the absolute $g_I$ factors with measurements by the NMR method, the chemical shifts of the NMR frequencies caused by the hydrate surrounding of the alkali ions in the NMR probe are determined. (auth)

## Nuclear Properties and Reactions, 20 ≤ A ≤ 38

*Refer also to abstracts 20938, 21091, 21095, 21154, 21161, 21172, 21177, 21179, 21197, 21199, and 21249.*

**21180** (ANL/NDM-10) CROSS SECTIONS FOR (n,p) REACTIONS ON $^{27}$Al, $^{46,47,49}$Ti, $^{54,56}$Fe, $^{58}$Ni, $^{59}$Co, AND $^{64}$Zn FROM NEAR THRESHOLD TO 10 MeV. Smith, D. L.; Meadows, J. W. (Argonne National Lab., Ill. (USA)). Jan 1975. Contract W-31-109-Eng-38. 57p. Dep. NTIS $6.00.

Cross sections for the $^{27}Al(n,p)^{27}Mg$, $^{46,47,49}Ti(n,p)^{46,47,48}Sc$, $^{54,56}Fe(n,p)^{54,56}Mn$, $^{58}Ni(n,p)^{58}Co$, $^{59}Co(n,p)^{59}Fe$, and $^{64}Zn(n,p)^{64}Cu$ reactions were measured by the activation method for neutron energies from near threshold to ~10 MeV. Measurements were made relative to the $^{235}U$ ($E_n \lesssim 4$ MeV) and $^{238}U$ ($E_n \gtrsim 4$ MeV) fission cross sections by using a fission detector neutron flux monitor. The results are compared with representative data from previously reported investigations. Tables of evaluated cross sections derived from the present work are presented for use in applications. (12 figures, 20 tables) (auth)

**21181** (HU-P-74/73) INVESTIGATION OF EXCITED STATES IN $^{32}$S BY THE $^{31}P(p,\gamma)^{32}S$ REACTION. Viitasalo, M.; Forsblom, I. (Helsinki Univ. (Finland). Dept. of Physics). Feb 1974. 23p. INIS.

The $^{31}P(p,\gamma)^{32}S$ reaction was studied in the proton energy region 300 to 1420 keV using Ge(Li)-techniques. Gamma decay schemes of 16 resonances are proposed. The branching ratios of resonance states and 23 bound states are presented. The spin of the $E_x$ = 7116 keV level was found to be $J^\pi = 2^+$. In addition, the present results are compared with earlier ones. (auth)

**21182** (ZFK-271, pp 85-90) LEVEL DENSITY PARAMETERS FROM (n,n')-SPECTRA AT 14 MeV AS CRITERION FOR PRE-EQUILIBRIUM EMISSION. Meister, A.; Seeliger, D.; Seidel, K.; Shahin, F. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Absolute neutron emission spectra for elements in the mass number range from 23 to 209 are analyzed with statistical models of nuclear reactions in an energy range 2 to 14 MeV. The high energy part of the spectra can be explained by neutron emission from pre-equilibrium states only. But the models of pre-equilibrium decay indicate also in the low energy part remarkable contributions to the neutron emission, so that the resulting equilibrium (compound nucleus) emission appears diminished as well as changed in the spectral shape. The role of the level density parameter is explained. (JFP)

**21183** (ZFK-271, pp 99-101) PROBABILITY OF TRANSITIONS BETWEEN PRE-EQUILIBRIUM STATES FROM THE NEUTRON INELASTIC SCATTERING SPECTRA. Zeliger, D.; Zeidel, K.; Meister, A. (Technische Univ., Dresden). Feb 1974. (In Russian).

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The values of $_2\lambda$ for elements with mass number $24 \leq A \leq 201$ were calculated from the absolute neutron emission spectra at incident neutron energies of 14 MeV. The results obtained were compared with the values calculated by other methods. (JSR)

**21184** (ZFK-271, pp 102-108) INELASTIC SCATTERING OF 3.2- AND 3.4-MeV NEUTRONS FROM $^{23}$Na, $^{31}$P, $^{55}$Mn, AND $^{209}$Bi. Mohamed, M.; Schweitzer, T.; Seeliger, D.; Seidel, K.; Unholzer, S. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Measurements were made to determine the angular distribution of inelastic scattering from low lying states of the nuclides sodium-23, phosphorus-31, manganese-55, and bismuth-209 in the range from 20 to 150° at 3.2 to 3.4 MeV were carried out with the time-of-flight technique. (JFP)

**21185** (ZFK-271, pp 165-166) THEORETICAL DESCRIPTION OF THE CONTINUOUS SPECTRUM OF 14-MeV NEUTRONS SCATTERED INELASTICALLY BY $^{28}$Si. Hermsdorf, D.; Hoehn, J.; Kiessig, G.; Seidel, K. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei: Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The emission of neutrons from compound states can be described using the Hauser–Feshbach formalism. On the basis of this model it is possible to calculate the differential cross sections for the decay of the compound nucleus into isolated states of the residual

nuclei. The advantage of this method consists in the conservation of the total angular momentum and the parity via the studied reaction. (JFP)

**21186** OPTICAL MODEL AND DWBA ANALYSIS OF THE α-PARTICLE SCATTERING FOR THE NUCLEI $^{26}$Mg AND $^{28,30}$Si INCLUDING HAUSER–FESHBACH CONTRIBUTIONS. Wuehr, W.; Hofmann, A.; Philipp, G. (Erlangen-Nuernberg Univ., Erlangen (F. R. Germany). Physikalisches Inst.). Z. Phys.; 269: No. 4, 365-371(Sep 1974).

7 figs.; 2 tabs.; 26 refs.

The elastic and inelastic α-scattering cross section has been measured for the nuclei $^{26}$Mg, $^{28,30}$Si at 15 bombarding energies between 15.0 and 16.4 MeV. The energy-averaged scattering cross sections can be described by an incoherent sum of contributions from direct and compound reactions. The direct reaction part has been calculated by the optical model or DWBA; the compound reaction part, by a simple Hauser–Feshbach formula. From the analyses deformation parameters and spin cut-off parameters are obtained. (7 figures, 2 tables) (auth)

**21187** SECONDARY-ELECTRON EMISSION FROM VARIOUS MATERIALS BOMBARDED WITH PROTONS AT $E_p < 2.5$ MeV. Foti, G.; Potenza, R.; Triglia, A. (Univ., Catania, Italy). Lett. Nuovo Cim.; 11: No. 15, 659-661(14 Dec 1974).

An experimental investigation is made of the connection between electron emission and the stopping cross section. The secondary electron yield from the targets of Al, Si, Cu, and Ge bombarded with protons was measured. (JFP)

**21188** (α,γ) REACTION ON LIGHT NUCLEI (REVIEW). Somorjai, E. ATOMKI (At. Kut. Intez.) Kozlem.; 16: No. 3, 243-260(1974). (In Hungarian).

A review is presented of the experimental techniques and γ spectrometry of (α,γ) reactions on light nuclei. (7 figures, 1 table) (JSR)

**21189** PROTON SHELL STRUCTURE OF MASS 28-32 NUCLEI. Mackh, H.; Mairle, G.; Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F.R. Germany)). Z. Phys.; 269: No. 4, 353-364(Sep 1974).

16 figs.; 7 tabs.; 38 refs.

Energy spectra of $^3$He particles from the (d,$^3$He) reaction on $^{28,29,30}$Si, $^{31}$P and $^{32}$S have been measured at an incident energy of 52 MeV. Spectroscopic factors have been determined by comparison of measured and DWBA angular distributions. The results are compared with predictions of recent shell model calculations. Excitation energies and spectroscopic strengths of low-lying positive-parity states are fairly well described. The $1d_{\frac{5}{2}}$ hole strengths distributions are not reproduced. The measured 1p hole strength decreases rapidly from $^{28}$Si to $^{32}$S. The occupation numbers of the different subshells show a considerably smoothed Fermi surface for these nuclei. (auth)

**21190** HIGH SPIN NEGATIVE PARITY STATES IN $^{35}$Cl. Lornie, P. R. G.; Jayasinghe, E. M.; Jones, G. D.; Price, H. G.; Thomas, M. F.; Twin, P. J.; Nolan, P. J. (Univ. of Liverpool). J. Phys., A (London); 7: No. 16, 1977-1984(1 Nov 1974).

The nucleus $^{35}$Cl has been studied using the reaction $^{32}$S (α,pγ) $^{35}$Cl. Proton–gamma ray angular correlations have been measured using an E/DE telescope to detect the protons. Gamma ray linear polarizations have been measured with a three Ge(Li) Compton polarimeter. The levels at 4348 keV, 5408 keV and 6088 keV have been shown to have spins and parities of $\frac{3}{2}^-$, $\frac{11}{2}^-$ and $\frac{13}{2}^-$, respectively. Branching ratios and electromagnetic multipole mixing ratios were also determined. The lifetime of the 5408 keV level was measured to be 400 ± 100 fs by the Doppler shift attenuation method, and a lifetime of 9.3 ± 0.8 ps was obtained by the recoil distance method for the 6088 keV level. Electromagnetic transition strengths were deduced for the decays of these levels and were found to be inconsistent with the levels' being interpreted as members of a rotational band based on the $\frac{7}{2}^-$ level at 3163 keV. (auth)

**21191** NEW LEVELS IN $^{23}$Ne. Christiansson, J. E.; Dubois, J.; Odelius, H.; Roth, H. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 10: No. 1-2, 65-72(Jul 1974).

The $^{22}$Ne(d,pγ)$^{23}$Ne-reaction was studied using particle-gamma and gamma-gamma coincidence techniques. An annular, surface barrier detector and Ge(Li) detectors were used together with multi-dimensional storage of data in a PDP-15 on-line computer. Energies and gamma radiation branching ratios of levels in $^{23}$Ne up to 4.0 MeV were measured. New levels at 3 458.2 ± 0.6 keV, 3 830.5 ± 1.2 keV, 3 843.3 ± 1.1 keV and 4 010 ± 3 keV are suggested. All levels up to 4 MeV were accounted for by the Nilsson model by including Coriolis mixing and by assuming that the nucleus is not deformed in the 2 $s_{\frac{1}{2}}$-state at 1017 keV. Gamma radiation branching ratios are discussed. The experimental results are also compared with recent shell model calculations. (auth)

**21192** AN INVESTIGATION OF EXCITED STATES IN $^{32}$S BY THE $^{31}$P(p,γ)$^{32}$S REACTION. Viitasalo, M.; Forsblom, I. (Helsinki Univ. (Finland). Dept. of Physics). Z. Phys.; 269: No. 2, 173-179(1974).

The $^{31}$P(p,γ)$^{32}$S reaction has been studied in the proton energy region 300–1,420 keV by using Ge(Li) techniques. Gamma decay schemes of 16 resonances are proposed. The branching ratios of the resonance states and 23 bound states are presented. The spin of the $E_x$ = 7,116 keV level was found to be $J^\pi = 2^+$. In addition, the present results are compared with earlier ones. (auth)

**21193** GIANT MULTIPOLE RESONANCE EFFECTS IN $^{27}$Al(pn)$^{27}$Si. Amos, K. A.; Geramb, H. V. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Kernphysik). Z. Phys.; 270: No. 2, 149-154(Oct 1974).

A set of ten differential cross sections between 10 and 40 MeV for this charge exchange reaction have been analyzed. In the analyses, amplitudes associated with the virtual excitation of the giant dipole and quadrupole resonances in $^{28}$Si complement those associated with the direct reaction mechanism. Such resonance effects are essential to explain the rapid energy variation of the data. (auth)

# Nuclear Properties and Reactions, 39 ≤ A ≤ 58

*Refer also to abstracts 21003, 21154, 21179, 21180, 21182–21184, 21205, 21209, and 21273.*

**21194** (ZFK-271, pp 77-80) PRE-COMPOUND DECAY AND OPTICAL MODEL. Herrmann, U.; Reif, R.; Seeliger, D.; Seidel, K. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Transition rates were used to calculate the absolute spectra of the reaction $^{55}$Mn(n,n′) for 14-MeV neutrons with a volume absorption of Woods–Saxon shape as well as a surface absorption of Woods–Saxon derivative type. (JFP)

**21195** NUCLEAR SPECTROSCOPY INVESTIGATIONS RELATED TO THE LEVEL DIAGRAMS OF THE NUCLEI $^{56}$Fe AND $^{56}$Co. Hofmann, S. Z. Phys.; 270: No. 2, 133-147(Oct 1974). (In German).

9 figs.; 7 tabs.; 38 refs. Thesis.

Gamma–gamma directional correlations have been investigated for several cascades in $^{56}$Fe formed in the decay of $^{56}$Mn or $^{56}$Co. A combination of NaI(Tl) and Ge(Li) detectors was used for the experiments. It was established that a level at 3,601 keV is populated in the decay of $^{56}$Co. Spins given in the parentheses were assigned to levels at the following energies: 2,658(2), 2,960(2), 3,123(4), 3,370(2), 3,445(3), 3,601(2), 3,856(3), 4,049(3), 4,100(4), 4,120(3), 4,298(4), 4,395(3) and 4,459 keV (3,4). Multipole mixing ratios were determined for γ transitions of the following energies: 978, 1,038, 1,175, 1,360, 1,772, 1,811, 1,964, 2,015, 2,035, 2,113, 2,213, 2,523, 2,599, 3,010, 3,302, 3,254, 3,273, 3,451 and 3,584 keV. The γ-rays from the decay of $^{56}$Co of energies 674.7 and 2,657.4 keV have been observed for the first time, and the presence of several other weak γ-rays in the $^{56}$Fe decay has been confirmed. Nine angular correlations in the decay of $^{56}$Ni have been investigated. The spin sequence 4, 3, 2, 0, 1 was unambiguously determined for the levels at 0, 158.2, 970.1, 1,450.7 and 1,720.0 keV. The multipolarity of the γ-rays of energies 158.2, 749.9 and 811.9 keV was determined as almost pure M1. The results are discussed within the framework of recent shell model calculations. (9 figures, 7 tables) (auth)

**21196** SPINS OF LEVELS IN $^{41}$Ca FROM (d,pγ) ANGULAR CORRELATIONS. Cornell, J. C. (Cape Town Univ. (South Africa). Dept. of Physics); McMurray, W. R. (Southern Universities Nuclear Inst., Faure (South Africa)). Z. Phys.; 269: No. 4, 315-322(Sep 1974).

4 figs.; 1 tab.; 30 refs.

Proton–gamma ray angular correlations are reported for the (d,p) reaction populating levels in $^{41}$Ca with $l_n = 1$. The method differs from previous measurements in that all observed gamma-ray transitions from each level of interest are included in the correlation. A spin and parity of $\frac{3}{2}^-$ is deduced for the 1.943, 2.462, 4.187 and 4.604 MeV levels. The results for the 3.944 and

4.753 MeV levels are consistent with a spin and parity assignment of $\frac{1}{2}^-$. (4 figures, 1 table) (auth)

**21197** INELASTIC INTERACTIONS OF HADRONS WITH NUCLEI IN THE RANGE 200 TO 2000 GeV. Azimov, S. A.; Abdullaev, A. M.; Mullazhanov, E. Zh.; Myalkovskii, V. M.; Nuritdinov, Kh.; Khen, E.; Yuldashbaev, T. S. (Physical-Technical Inst., Tashkent). Bull. Acad. Sci. USSR, Phys. Ser. (Engl. Transl.); 38: No. 5, 1-4(1974).

From all-union conference on cosmic-ray physics; Kharkov, USSR (25 Sep 1973). Translated from Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 5, 898-901(1974).

Experimental data are reported on the partial inelasticity for the interaction of pions and nucleons with lead nuclei. The inelasticity $K_{in}$ is found as a function of the atomic number of material. The Monte Carlo method is used to calculate the sampling efficiency for two-fireball showers. (auth)

**21198** HIGH SPIN STATES IN $^{39}$K FROM THE $^{36}$Ar($\alpha$, p$\gamma$)$^{39}$K REACTION. Alenius, G.; Arnell, S. E.; Stankiewicz, O. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 10: No. 1-2, 43-50(Jul 1974).

The decay properties of high spin states in $^{39}$K were investigated by means of the $^{36}$Ar($\alpha$, p$\gamma$)$^{39}$K reaction at E = 10 to 14 MeV. From measurements of the yield function and the angular distribution of the $\gamma$-transitions it can be concluded that the following states were excited: 2814 keV, $\frac{7}{2}^-$, 3597 keV, $\frac{5}{2}^-$, 3943 keV, $11/2^-$, 4126 keV, $\frac{5}{2}^{(-)}$, 4521 keV, $\frac{9}{2}^{(-)}$ ($11/2^-$), 5717 keV, $\frac{13}{2}$ and 6474 keV, ($\frac{15}{2}$). Multipole mixing ratios and transition strengths are given for some transitions. Comparisons are made with a recent shell-model calculation and with calculations involving collective features. (auth)

**21199** LEVEL ASSIGNMENTS IN $^{40}$K FROM POLARIZATION MEASUREMENTS. Thomas, M. F.; Davis, C. K.; Jones, G. D.; Price, H. G.; Twin, P. J. (Univ. of Liverpool). J. Phys., A (London); 7: No. 16, 1985-1994(1 Nov 1974).

Levels at 2291 keV, 2543 keV, 2786.6 keV and 2879 keV in $^{40}$K were studied using the $^{37}$Cl($\alpha$,n$\gamma$)$^{40}$K reaction at a bombarding energy of 8.0 MeV. Angular distributions and polarizations were measured for transitions from these levels. This polarization information combined with that from earlier angular correlation measurements gives unique assignments of $J^\pi = 7^+$ for the 2543 keV level and $J^\pi = 3^+$ for the 2786.6 keV level. The 2879 keV level is established as J = 6. Combining the polarization results with those of a single-particle transfer experiment, $J^\pi = 3^-$ is favored for the 2291 keV level. Simple shell-model calculations aimed at interpreting the new data are reported. (auth)

**21200** STUDIES OF THE ELASTIC AND INELASTIC NEUTRON SCATTERING ON CHROMIUM IN THE ENERGY RANGE 3.45 TO 4.30 MeV. Wollesen, M. (Kiel Univ. (F. R. Germany). Mathematisch-Naturwissenschaftliche Fakultaet). 8 Jul 1972. 64p. (In German). INIS. Available from the library of the Kiel Univ.

The elastic and inelastic scattering of fast neutrons on $^{54}$Cr has been investigated with the help of the time-of-flight method. A Van-de-Graaff accelerator of 1.5 MeV maximum energy and about 75 $\mu$A ion current is used to produce neutrons; in connection with a deuterium gas target, the accelerator supplies neutrons in the energy region around 4 MeV by the reaction D(d,n)$^3$He at an energy resolution of about 120 keV. In order to measure the neutron time of flight, a pulsing of the ion beam is required; pulses result after the acceleration with the help of two deflector pairs perpendicular to one another, on which high frequency voltages of 2 MHz are placed, which are moved against each other in the phase so that the beam describes ellipses in a diaphragm plane and with each revolution sweeps once over a small rectangular diaphragm. The dimensioning of the beam pulsing system is described. The neutrons are scattered on a sample hung up at a distance of 10.6 cm in front of the target on the prolongation of the beam axis and are detected after 1.5 m flight path by the detector (scintillator NE213). In the time-of-flight spectra, one can separate, besides the elastic group, 4 to 7 inelastic groups depending on the incident energy; with one exception, all can be traced back to nuclear excitation of the isotope $^{52}$Cr. The differential effective cross sections are determined from the momentum numbers measured for the individual groups; and from this, by integration over the solid angle, the excitation cross sections of the individually grouped levels, the whole inelastic, elastic and total effective cross sections are calculated. The inelastic angular distributions are almost isotropic for all neutron groups in the center of gravity system; occasionally, a slight minimum or maximum occurs around the scattering angle 90°. All measured values are corrected for anisotropy of the source, flow weakness in the sample, multiscattering and for different detector sensitivities. (GE)

**21201** $6^+$ ISOMER STATE IN $^{46}$Ca. Bizzeti, P. G. (Univ., Florence); Maurenzig, P. R.; Poggi, G.; Bianco, G. L. Lett. Nuovo Cim.; 12: No. 2, 53-59(11 Jan 1975).

The decay of the expected isomer, obtained from the reaction $^{48}$Ca(p,p2n)$^{46}$Ca was observed as a delayed activity after bombardment of a 97.2% enriched $^{48}CaCO_3$ target with 35-MeV protons. Gamma spectra are found, and the energy of the isomeric state comes out to be 2.974 MeV. (JFP)

# Nuclear Properties and Reactions, 59 ≤ A ≤ 89

*Refer also to abstracts 21089, 21095, 21154, 21172, 21182, 21183, 21187, 21209, and 21225.*

**21202** (KFK-EXT-3/74-2) MEASUREMENT OF THE HALF-LIFE OF RECOIL NUCLEI AND THE ORIENTATION OF THEIR SPINS FOLLOWING THE BETA DECAY OF $^{73}$Se. Schwall, M. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Experimentelle Kernphysik; Karlsruhe Univ. (TH) (F. R. Germany). Fakultaet fuer Physik). Feb 1974. 87p. (In German). INIS.

23 figs.; 2 tabs.; 44 refs. With abstract in German and English.

This paper reports on experiments using recoil nuclei arising from an allowed beta decay. As a radioactive source $^{73}$Se was used. The half-life of the 428-keV level in the daughter nucleus has been determined to be $(5.0 \pm 0.6) \times 10^{-6}$ sec, in full agreement with preceding measurements. This time is convenient for observation of recoil nuclei in flight. The spin orientation of recoil nuclei with respect to their direction of flight has for the first time been determined, whereby the anisotropy of the gamma radiation emitted by the recoil nuclei in flight was registered. Use was made of the counting rate difference between an essentially unperturbed angular correlation and a correlation totally disturbed by a suitable applied magnetic field. From the sign of the anisotropy the ground-state spin of $^{73}$Se has been determined to be 9/2. This result is in contradiction to measurements employing conversion coefficients for the spin determination. Arguments are presented which may clarify the ambiguity. The size of the anisotropy is related to disturbance effects by the atomic electron shells. (23 figures, 2 tables) (auth)

**21203** (ZFK-271, pp 184-194) SOME PRELIMINARY RESULTS OF INVESTIGATIONS FOR EVALUATION OF $^{93}$Nb NEUTRON EMISSION CROSS SECTIONS. Hermsdorf, D.; Kiessig, G.; Passkoenig, K.; Seeliger, D.; Storch, R. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

In the bulk of experimental and theoretical nuclear data for $^{93}$Nb there are notorious differences. Having regard to the growing interest in exact data it seems to be necessary to clarify this situation. Aiming at this some theoretical methods are presented and proposed, and their preliminary results are discussed in part. (auth)

**21204** THE HALF-LIFE OF $^{87}$Rb MEASURED AS DIFFERENCE BETWEEN THE ISOTOPES $^{87}$Rb AND $^{85}$Rb. Neumann, W.; Huster, E. (Muenster Univ. (F. R. Germany). Inst. fuer Kernphysik). Z. Phys.; 270: No. 2, 121-127(Oct 1974).

4 figs.; 2 tabs.; 24 refs. Thesis by W. Neumann.

The half-life T of $^{87}$Rb was determined by means of a $4\pi$ proportional counter using thin sources of RbCl on thin conducting backings. The total thickness D investigated (RbCl + support) ranged from 11 to 525 $\mu g/cm^2$. Comparative measurements with (inactive) layers of $^{85}$RbCl showed that, in the energy range below 185 eV, RbCl layers give rise to spurious pulses. Linear extrapolation of the specific activity below D = 45 $\mu g/cm^2$ to D = 0 $\rightarrow$ $4.88 \times 10^{10}$ y with a positive uncertainty of $0.06 \times 10^{10}$ y and a negative uncertainty of $0.1 \times 10^{10}$ y. Previously published half-lives are discussed. (4 figures, 2 tables) (auth)

**21205** ON THE GAMMA DECAY OF ANALOGUE RESONANCES IN THE $^{58}$Fe(p,$\gamma$)$^{59}$Co REACTION. Keinonen, J.; Anttila, A.; Bister, M. (Helsinki Univ. (Finland). Dept. of Physics). Z. Phys.; 270: No. 2, 129-132(Oct 1974).

1 fig.; 5 tabs.; 21 refs.

Resonances in the reaction $^{58}$Fe(p,$\gamma$)$^{59}$Co have been studied in the analogue region $E_p$ = 2.20-2.25 MeV. The $\gamma$-ray decays of fourteen resonances and the energies of nine bound states have been obtained by using an 80-cm$^3$ Ge(Li) detector. The Q-value was found to be 7,359.7 ± 3.0 keV. One-lifetime and six-lifetime limits were determined from the Doppler-shift attenuation method for bound states. (1 figure, 5 tables) (auth)

**21206** IN-BEAM GAMMA-RAY AND ELECTRON SPECTROSCOPY FOLLOWING THE $^{75}As(p,n)^{75}Se$ REACTION. Agarwal, Y. K. (Tata Inst. of Fundamental Research, Bombay); Baba, C. V. K.; Bharathi, S. M.; Bhattacherjee, S. K.; Lal, B.; Sahai, B. Pramana; 3: No. 4, 243-260(Oct 1974).

The level scheme of $^{75}Se$ was studied through the $^{75}As(p,n)$ reaction at proton energies from 1.5 to 5.0 MeV. The $\gamma$-ray and internal conversion electron measurements were made using NaI(Tl) and Ge(Li) detectors and a six-gap electron spectrometer. A proportional counter and a thin window NaI(Tl) detector were used to detect $\gamma$-rays with energies less than 30 keV. The level scheme was established by observing the thresholds of various $\gamma$-rays and by $\gamma$-$\gamma$ and $e^-$-$\gamma$ coincidence measurements. New levels at 133.0, 293.2, 790.0, 953.0, 1020.8, 1184.3, 1198.5 and 1258.2 keV not observed in earlier (p,n) studies were established. Conversion coefficients of most of the lowlying transitions were determined. Angular distributions of some of the $\gamma$-rays were also measured and compared with the statistical model calculations. Definite $J^\pi$ assignments were made to most of the lowlying levels. Lifetimes of the 112.1, 133.0, 286.7 and 293.2 keV levels were measured to be $0.69 \pm 0.12$, $5.3 \pm 0.6$, $1.35 \pm 0.15$ and $31 \pm 2$ nsec respectively. The reduced transition probabilities for various lowlying transitions were determined and compared with recent calculations. The $\frac{1}{2}^-$ and $\frac{9}{2}^+$ levels hitherto unknown in this nucleus were identified. The structure of the lowlying levels is discussed in terms of the existing models. (auth)

**21207** THE DECAY OF $^{62}Zn$. Jongsma, H. W.; Kamermans, R.; Verheul, H. (Amsterdam Univ. (Netherlands). Natuurkundig Lab.). Z. Phys.; 270: No. 2, 89-92(Oct 1974).

Energies and relative intensities of 31 $\gamma$ transitions from the decay of $^{62}Zn$ have been measured using an anti-Compton spectrometer. Gamma-gamma coincidence measurements were performed. Besides the levels of $^{62}Cu$ for which the population in the decay of $^{62}Zn$ was known, also levels at 644.82, 698.32, 1,221.5 and 1,525.9 keV in $^{62}Cu$ are found to be populated. The previously proposed $\beta$ feeding of $^{62}Cu$ levels at 1,142.5 and 1,280.8 keV is ruled out. (auth)

## Nuclear Properties and Reactions, $90 \leq A \leq 149$

*Refer also to abstracts 21159, 21172, 21182, 21183, 21251, 21254, and 21270.*

**21208** (AECL-4829) CALCULATION OF DOPPLER-SHIFT ATTENUATION. Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Sep 1974. 52p. Dep. NTIS (US Sales Only) $5.75. AECL $1.50.

Programs used in calculating Doppler-shift attenuation spectra of $\gamma$ rays are listed and described. The programs are written in CDC-6600 FORTRAN Extended. The analysis, which has been described in detail in a separate publication, is exact within the usual Lindhard model of the slowing down of heavy ions in solids. (auth)

**21209** (LBL-3450) TABLE OF NUCLEAR MOMENTS. Shirley, V. S.; Lederer, C. M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 22p. (CONF-740633-6). Dep. NTIS $4.25.

From international conference on hyperfine interactions studied in nuclear reactions and decay; Uppsala, Sweden (10 Jun 1974).

This table contains nuclear magnetic and quadrupole moments reported as of September 1, 1974. In addition, the appropriate level half-life and the measuring method used are tabulated. (RWR)

**21210** (ORNL-TM-4810) LSFIT: A LEAST SQUARES COMPUTER PROGRAM TO FIT NEUTRON CAPTURE CROSS SECTION RESONANCE DATA FOR ORELA. Macklin, R. L. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 15p. Dep. NTIS $4.00.

The LSFIT programs provide least-squares-adjusted Breit-Wigner single-level two-channel parametric fits to ORELA neutron capture spectra from the Flight Path 7 (40-meter) facility. The program is restricted by matrix size to 500 data channels and sixteen or fewer resonances. It is compiled in FORTRAN IV for faster execution on the IBM 360/91. Smooth convergence is controlled by preassigned damping factors for each (≤49) adjustable parameter. Trial parameters are used to generate each resonance line shape. Doppler broadening to an effective temperature is done by using the real part of the complex error function. Capture yield for the given sample thickness is computed by integration over each data channel and then convoluted with a (Gaussian) resolution function. An approximate first scattering yield is also computed for each resonance and a residual 1/v background (if any) can be fitted. A typical 16 resonance run took 240 K of core and four seconds for seven iterations on the IBM 360/91. (RWR)

**21211** (ZFK-271, pp 80-85) PRE-COMPOUND AND COMPOUND NUCLEUS EMISSION IN NUCLEAR REACTIONS WITH MULTIPLE NUCLEON EMISSION AT 14 MeV NEUTRON INCIDENT ENERGY. Herrmann, U.; Seeliger, D.; Seidel, K. (Technische Univ., Dresden). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The influence of pre-compound emission on multiple nucleon emission after bombardment with 14-MeV neutrons is considered. The reactions with secondary neutrons and protons: (n,nn), (n,np), (n,pn), and (n,pp) with the nuclei niobium-93 and tantalum-181 are discussed. The portion of these secondary nucleons which are emitted still in the pre-equilibrium state, their spectral distribution, and the influence of nonequilibrium contributions for the emission of primary particles on the cross sections of reactions with multiple particle emission are treated. (JFP)

**21212** (ZFK-271, pp 91-94) SOME RECENT EXPERIMENTS ON NEUTRON-NUCLEUS INTERACTIONS IN THE INSTITUTE OF EXPERIMENTAL PHYSICS, DEBRECEN (HUNGARY). Angeli, I. (Kossuth Univ., Debrecen, Hungary). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Experimental research on neutron reactions is summarized. (JFP)

**21213** (ZFK-271, pp 94-97) DIFFERENTIAL EMISSION CROSS SECTION FOR NEUTRONS DURING THE INTERACTION OF 14-MeV NEUTRONS WITH NUCLEI. Gebel, I.; Zeliger, D.; Zeidel, K.; Meister, A.; Shahin, F. (Technische Univ., Dresden). Feb 1974. (In Russian).

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The experimental conditions for measuring the differential neutron emission cross section for a number of elements were described. The results obtained for the differential emission cross section at a neutron energy of 14 MeV was shown graphically for Cd. (JSR)

**21214** (ZFK-271, pp 132-145) INTERMEDIATE STRUCTURE CONNECTED WITH THE COMPOUND NUCLEUS EXIT CHANNELS. Brzosko, S. (Univ., Warsaw). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

An attempt is made to demonstrate that the compound nucleus exit states are connected with the same intermediate structure as are the doorway states and that in the wide range of energies they may play a dominating role in the description of the reactions. The reactions $^{110}Cd(p,\gamma)$, $^{115}In(n,\gamma)$ $Sn(\gamma,\gamma)$, $Sn(p,n)$, and $Sn(n_{tn},\gamma)$ are studied for compound-nucleus exit states. (JFP)

**21215** THE BETA DECAY OF $^{146}Pm$ WITH MICROSCOPIC NUCLEAR WAVE FUNCTIONS. Krinn, H. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Theoretische Physik). Z. Phys.; 269: No. 4, 373-378(Sep 1974).

1 fig.; 4 tabs.; 11 refs. Part of a thesis.

Explicit numerical values are given for the matrix elements of the first-forbidden $\beta$ decay of $^{146}Pm$ to the $2^+$ state of $^{146}Sm$. The odd-odd nucleus $^{146}Pm$ is assumed to have a structure similar to neighboring even-even nuclei to which an odd neutron and an odd proton are coupled. The wavefunctions of the even-even nuclei are calculated starting from Bohr's Hamiltonian. (auth)

**21216** OBSERVATION OF THE YRAST AND STATISTICAL CASCADES IN (HEAVY-ION, $xn\gamma$) REACTIONS. Newton, J.O.; Lisle, J.C.; Dracoulis, G.D.; Leigh, J.R.; Weisser, D.C. (Department of Nuclear Physics, Australian National University, Canberra, Australian Capital Territory, 2600, Australia). Phys. Rev. Lett. 34: No. 2, 99-103 (13 Jan 1975).

The energy spectra and angular distributions of the yrast and statistical cascades in $^{160,162}Yb$ have been obtained from measurements of the reactions $^{147,149}Sm(^{16}O,3n)$ and $^{148,150}Sm(^{16}O,4n)$. An average of about six yrast and six statistical $\gamma$ rays occur in the $4n$ reaction. The data suggest that the yrast $\gamma$ rays are mostly stretched E2. (auth)

**21217** ONE- AND MULTI-STEP PROCESSES IN THE REACTION $^{144}Nd(^{12}C, ^{14}C)$. Yagi, K.; Hendrie, D.L.; Kraus, L.;

Maguire, C.F.; Mahoney, J.; Scott, D.K.; Terrien, Y. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Udagawa, T.; Low, K.S.; Tamura, T. Phys. Rev. Lett. 34: No. 2, 96-99 (13 Jan 1975).

Two very different types of angular distributions, one having a normal bell shape and the other being much more constant with angle, were observed in the reaction $^{144}$Nd($^{12}$C, $^{14}$C) for two well-known $2^+$ states of $^{142}$Nd. The fits to these angular distributions using the distorted-wave Born approximation and/or coupled-channel Born approximation confirms the conclusion that the data give definite evidence for the importance of multi-step processes. A comparison with the reaction $^{144}$Nd($p$, $t$) is also discussed. (auth)

**21218** HALF-LIFE OF THE $6^+$ STATE IN $^{134}$Te AND THE EFFECTIVE $1g_{\frac{9}{2}}$ PROTON CHARGE. Blomqvist, J.; Borg, S.; Kerek, A.; Rensfelt, K. G.; Sztarkier, J. (Research Institute for Physics, Stockholm). Phys. Scr.; 9: No. 6, 321(Jun 1974).

The half-life of the $6^+$ isomeric state at 1691 keV in $^{134}$Te was measured: $T_{\frac{1}{2}}$ = (196,7)ns. For the $1g_{\frac{9}{2}}$ proton orbit $e_{eff}$ = (1.45,0.11) e was obtained by comparing the experimental and theoretical B(E2) values. (auth)

**21219** NUCLEAR SPINS OF SOME NEUTRON-DEFICIENT TIN ISOTOPES. Hoegervorst, W.; Ekstroem, C.; Ingelman, S.; Wannberg, G. (Uppsala Univ.). Phys. Scr.; 9: No. 6, 317-320 (Jun 1974).

The nuclear spins of some neutron-deficient isotopes were measured by the atomic-beam magnetic resonance method. The results are: $^{109}$Sn (18.0 min) I = $^1/_2$, $^{110}$Sn (4.0 h) I = 0, $^{111}$Sn (35.3 min) I = $^1/_2$ and $^{113m}$Sn (21.4 min) I = $^1/_2$. The spin values are compared with predictions from spectroscopic and theoretical studies. (auth)

**21220** DECAY OF 2.1-MIN AND 4.1-MIN $^{132}$Sb ISOMERS AND 2.3-MIN $^{133}$Sb. Erten, H. N.; Blachot, J. (Massachusetts Inst. of Tech., Cambridge (USA)). Radiochim. Acta; 19: No. 2, 84-90 (1973).

8 figs.; 3 tabs.; 23 refs.

In an investigation of $\gamma$-ray spectra of Sb isotopes rapidly isolated from $^{235}$U fission products, evidence was obtained for the existence of 2.1- and 4.1-min isomers of $^{132}$Sb and for a $^{133}$Sb half-life of 2.3 ± 0.3 min. Intense $\gamma$-rays with energies of 103.2, 697.4, and 974.6 keV were found to exhibit complex decay curves that could be resolved into 2.1± 0.3 and 4.1 ± 0.4 min components and were assigned to the decay of $^{132}$Sb isomers. Other equally intense $\gamma$-rays at 1,096.4, 1,728.2, and 2,751.7 keV showed half-lives of 2.3 ± 0.2 min and, as they were found to have no coincidence relationships with the above three $\gamma$-rays, were assigned to $^{133}$Sb decay. Observation of $\gamma-\gamma$ coincidences permitted the assignment of the 989.3-keV $\gamma$-ray to the decay of 2.1-min $^{132}$Sb, the 151.1- and 383.2-keV $\gamma$-rays to the decay of 4.1-min $^{132}$Sb and 8 additional $\gamma$-rays to the decay of 2.3-min $^{133}$Sb. Sixty additional $\gamma$-rays were found with half-lives near 2.2 min and may be assigned either to 2.1-min $^{132}$Sb or 2.3-min $^{133}$Sb. (auth)

**21221** STUDY OF THE LEVEL SCHEME OF $^{141}$Pr BY (n,n'$\gamma$) MEASUREMENTS. Singh, R.; Knitter, H. H. (Commission of the European Communities, Geel (Belgium). Central Bureau for Nuclear Measurements). Z. Phys.; 270: No. 2, 97-102(Oct 1974).

4 figs.; 1 tab.; 21 refs.

The level scheme of $^{141}$Pr was studied by measuring the gamma ray spectra from the inelastic scattering of neutrons with energies between 1.10 and 2.22 MeV. In addition to the levels below 1,651 keV, the levels at 1,785, 1,813, 1,842, 1,856, 1,975 and 2,016 keV were confirmed, and evidence was found for the existence of a previously proposed new level at 1,899 keV. A new transition 2,103 → 1,452 was added to the level scheme. No evidence was found in favor of the levels at 1,668 and 1,946 keV and of the transitions 1,651 → 1,435, 1,651 → 1,292 and 1,117 → 0. The relative intensities and the branching ratios of the transitions were determined and compared with the previous results. Spins and parities of some of the levels were deduced. (auth)

**21222** ISOTOPE SHIFT OF POTENTIAL AND DENSITY DISTRIBUTION RADII. Agrawal, D. C.; Sood, P. C. (Banaras Hindu Univ., India). Progr. Theor. Phys. (Kyoto); 51: No. 4, 1277-1279(Apr 1974).

Detailed investigations were made of the variation of nuclear potential radii for nuclei in isotopic sequences, and its correlation with the variation of corresponding charge distribution radii was studied. The main conclusions of these studies are presented. A local shell model potential was used. The isotopes tin-116, tin-118, tin-120, tin-122, and tin-124 were studied. (JFP)

**21223** CORE POLARIZATION AND EXCHANGE EFFECTS IN THE INELASTIC SCATTERING OF TRITONS FROM $^{92,94,96}$Zr. Grube, G. J.; Park, J. Y. (North Carolina State Univ., Raleigh). J. Phys., A (London); 7: No. 16, 2029-2040(1 Nov 1974).

A microscopic analysis of the inelastic scattering of 20 MeV tritons from $^{92}$Zr, $^{94}$Zr and $^{96}$Zr is carried out which includes core polarization effects and exchange effects. A semi-realistic Gaussian effective interaction between the incident triton and the target nucleon is used. Inclusion of the core polarization contribution is found to decrease the necessary direct interaction strength of the collective states by at least a factor of two from those predicted by the shell-model analysis. An estimate of the relative importance of exchange effects is made using a simple pseudopotential. Exchange terms are found to be important for most of the single-particle shell-model transitions studied. (auth)

**21224** ISOTOPE SHIFTS IN THE ATOMIC SPECTRUM OF XENON AND NUCLEAR DEFORMATION EFFECTS. Fischer, W.; Huehnermann, H.; Kroemer, G.; Schaefer, H. J. (Marburg Univ. (F. R. Germany). Fachbereich Physik). Z. Phys.; 270: No. 2, 113-120(Oct 1974).

Part of the thesis by H. J. Schaefer.

Optical isotope shifts of four lines in the atomic spectrum of xenon have been measured using enriched samples of all stable xenon isotopes. The spectrograms were recorded with the aid of a pressure-scanned Fabry-Perot interferometer and analyzed by digital data techniques. The measured isotope shifts are shown to be self-consistent by means of a King plot. An estimate of the specific mass effect is given, and the changes $\delta\langle r^2\rangle$ of the mean square radius of the nuclear charge distribution are extracted from the measured shifts. These changes $\delta\langle r^2\rangle$ are discussed in terms of the nuclear deformation parameter $\beta^2$. The results for the deformation of the stable even xenon isotopes are shown to be in good agreement with the systematics of deformation found for the neighboring elements from Coulomb excitation experiments. (auth)

**21225** EXCITED STATES IN $^{91}$Nb POPULATED IN THE $^{89}$Y($\alpha$,2n$\gamma$) REACTION. Berinde, A.; Dumitru, R. O.; Grecescu, M.; Iordachescu, A.; Neamu, I.; Pascovici, G.; Plostinaru, D.; Teodorescu, C. M. (Institutul de Fizica Atomica, Bucharest (Romania)). Z. Phys.; 269: No. 2, 117-123(1974).

The reaction $^{89}$Y($\alpha$,2n$\gamma$) was used to populate excited states in $^{91}$Nb. The de-excitation of these states was studied by in-beam gamma-ray spectroscopy, involving the measurement of excitation functions, angular distributions and life-times. A $^{17}/_2^-$ isomeric state at 2,034 keV with $T_{\frac{1}{2}}$ = 3,8 ± 0.2 $\mu$s was observed; it is interpreted as the highest-spin state of the $[(g_{\frac{9}{2}})^2(p_{\frac{1}{2}})]$ proton configuration. The experimental results are compared with other published data and with shell-model calculations. (auth)

**21226** THE ANGULAR CORRELATION OF THE 459.7-27.7 keV $\gamma-\gamma$ CASCADE IN $^{129}$I AND ITS USE FOR A TDPAC. Rots, M.; Van de Voorde, H.; Ooms, H.; Namavar, F.; Coussement, R.; De Readt, J. (Louvain Univ., Heverlee (Belgium). Inst. voor Kern- en Stralingsfysika). Z. Phys.; 270: No. 1, 51-54(Sep 1974).

In contrast to earlier measurements, the angular correlation coefficient of the 459.7-27.7 keV $\gamma-\gamma$ cascade in $^{129}$I has been found to be consistent with the mixing ratios of the transitions and equal to $A_{22}$ = -0.0305 ± 0.0037. Further, it is shown that this cascade can be used for time-differential hyperfine-interaction studies. (auth)

# Nuclear Properties and Reactions, 150 ≤ A ≤ 189

*Refer also to abstracts 20855, 21172, 21182, 21183, 21209, 21211, and 21216.*

**21227** (JINR-E6-8303) DECAY OF $^{159}$Tm (9.0 MIN) TO $^{159}$Er. Basnat, M. I.; Beyer, G.; Gromov, K. Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 26p. Dep. NTIS (US Sales Only) $4.50.

The decay of $^{159}$Tm ($T_{\frac{1}{2}}$ = 9.0 ± 0.4 min) was investigated with Ge(Li) and Si(Li) detectors, $\beta$ spectrographs, and a toroidal $\beta$ spectrometer by using isotopically separated samples produced by the YASNAPP facility at Dubna. The singles $\gamma$-ray spectrum, the conversion electron spectrum, the positron spectrum, and prompt and delayed $\gamma-\gamma$ coincidences were measured. By using strong thulium activities conversion electrons were also measured with high-resolution $\beta$ spectrographs. In the $^{159}$Tm decay 81 new $\gamma$-ray transitions were observed. A decay scheme of $^{159}$Tm is proposed involving 12 excited states in $^{159}$Er. First members of the rotational bands $3/2^-[521]$, $5/2^-[523]$, $3/2^+([402] + [651])$, $11/2^-[505]$, and $7/2^-[514]$ and the 5/2, 7/2, and 9/2 states of a strongly perturbed positive-parity band were identified. The Q value for $^{159}$Tm was determined to be 3.4 ± 0.3 MeV. (5 figures, 4 tables) (auth)

**21228** (ZFK-271, pp 109-111) MECHANISM OF THE REACTION (n,$\alpha$) CAUSED BY FAST NEUTRONS ON DEFORMED NUCLEI. Glowacka, L.; Jaskola, M.; Kozlowski, M.; Osakiewicz, W.; Turkiewicz, J.; Zemlo, L. (Inst. of Nuclear Research, Warsaw). Feb 1974. (In Russian).

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The results of studies on (n,$\alpha$) reactions induced by fast neutrons on deformed nuclei in the region A = 150 to 170 were reported and discussed. The experimental results were compared with calculations made on the basis of the assumption of a pre-equilibrium mechanism and an expulsion of $\alpha$ clusters. The results obtained from the pre-equilibrium calculations do not agree with the observed spectra. Good agreement was found between experiment and calculations based on a direct reaction for incident neutron energies of 14 MeV. This agreement worsens for increased energies. Typical experimental and theoretical curves are given for $^{151}$Eu, $^{150}$Dy, and $^{151}$Dy at 14.2 and 18.15 MeV. (JSR)

**21229** (ZFK-271, pp 146-149) NEUTRON STRENGTH FUNCTIONS IN STRIPPING. Bang, J. (Niels Bohr Inst., Copenhagen). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The variances of different energy levels and the cross sections of (d,p) reactions of $^{157,159,161}$Gd, $^{161,163,165}$Dy, $^{167,169,171}$Er, and $^{171,173,175,177}$Yb leading to relatively highly excited states were found at an incoming energy of 9 MeV. (JFP)

**21230** HINDRANCE FACTORS FOR UNIQUE FIRST-FORBIDDEN BETA-TRANSITIONS IN $^{161}$Tb. Prasad, K. G.; Nielsen, H. L. (Aarhus Univ., Denmark). Phys. Scr.; 9: No. 4, 208-210 (Apr 1974).

The absolute transition probabilities of unique first-forbidden $\beta$-transitions in the decay of 6.9 d $^{161}$Tb to $^{161}$Dy were measured. Relative to a Nilsson-model estimate with the pairing correction included, the particle transitions are found to be hindered by the following factors: n{521}$^3/_2^-$ → p{411}$^3/_2^+$: 3.0; n{523}$^5/_2^-$ → p{411}$^3/_2^+$: >0.1. (Notation: {Nn$_z$Λ}Kπ.) (auth)

# Nuclear Properties and Reactions, 190 ≤ A ≤ 219

*Refer also to abstracts 21172, 21182-21184, and 21209.*

**21231** (ZFK-271, pp 48-62) PRE-EQUILIBRIUM PROCESSES IN THE EXCITON MODEL. Ribansky, I.; Oblozinsky, P.; Betak, E. (Inst. of Physics, Bratislava). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei, Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

After a description of the Griffin exciton model, the general method of calculation of the final state densities, decomposition of the exact formulation of the exciton model in preequilibrium and equilibrium parts, application of the model to ($\alpha$,n) reactions and the test of the assumption $M^2$ = constant, and the emission of complex particles are treated. The integral emission excitation function, and preequilibrium fraction for ($\alpha$,n) reactions on gold-197, and the excitation functions for the ($\alpha$,n) reaction on tantalum-181 and vanadium-51, the spectra of d, t, helium-3, and alpha particles emitted in proton reactions with gold at 62 MeV are discussed. (JFP)

**21232** (ZFK-271, pp 69-70) PRE-EQUILIBRIUM DECAY OF NUCLEI IN PHOTONUCLEAR REACTIONS. Luk'yanov, V. K. (Joint Inst. for Nuclear Research, Dubna, USSR); Toneev, V. D.; Seliverstov, V. A. Feb 1974. (In Russian).

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The ($\gamma$,n) reactions were calculated on the basis of the Blann hybrid model modified for photonuclear reactions and on the basis of a theory based on the solution of so-called master equations also modified for photonuclear reactions. Experimental data on the photoneutron spectra of $^{197}$Au, obtained with bremsstrahlung radiation, were compared with the calculated data, and the results are shown graphically for $\gamma$ energies of 20 and 14 MeV. The results show that inclusion of the pre-equilibrium spectra significantly improves agreement with experimental data. (JSR)

**21233** SCHEMATICITY AND GROUND STATE CORRELATIONS IN THE LEAD ISOTOPES. Peltier, S. M.; Plastino, A. (La Plata Univ. Nacional (Argentina). Departamento de Fisica); Hernandez, E. S. (Buenos Aires Univ. Nacional (Argentina). Departamento de Fisica). Z. Phys.; 269: No. 4, 347-352(Sep 1974).

6 figs.; 4 tabs.; 11 refs.

The relationship between collectivity and ground-state correlations is analyzed for the single-closed-shell lead isotopes. The effects of the schematic approximation are discussed, within the framework of both the quasiparticle Random Phase Approximation and the quasiparticle Tamm-Dancoff approach. The consistency of the RPA is investigated. (auth)

**21234** LEVELS OF $^{195}$Au FROM THE DECAYS OF $^{195g}$Hg AND $^{195m}$Hg. Farzine, K.; Buttlar, H.v. (Bochum Univ. (F.R. Germany). Inst. fuer Experimentalphysik). Z. Phys.; 270: No. 2, 155-162(Oct 1974).

5 figs.; 2 tabs.; 7 refs.

The levels of $^{195}$Au were analyzed by observing $\gamma$ singles and $\gamma\gamma$ coincidences following the $^{195}$Hg decay. Nine new lines are found which require two new levels at 778 and 946 keV. An interpretation of the level scheme is given on the basis of the de Shalit core-excitation model. A qualitative understanding of all levels up to 1 MeV excitation energy is obtained. (auth)

**21235** ABSOLUTE K-CONVERSION COEFFICIENTS FROM THE X RAY GAMMA RAY SUMMING IN Ge(Li) DETECTORS. Mukherjee, P.; Dasmahapatra, B. K. (Saha Inst. of Nuclear Physics, Calcutta). J. Phys., A (London); 7: No. 16, 2008-2016 (1 Nov 1974).

A new method for the determination of absolute K-conversion coefficients is described. The K-conversion coefficients of the 569.7 keV and 1063.6 keV $\gamma$ rays in the decay of $^{207}$Bi(38 yr) and 316.5 keV $\gamma$ ray in the decay of $^{192}$Ir(74.2 d) are measured and they are found to agree with the reported data. (auth)

# Nuclear Properties and Reactions, A ≥ 220

*Refer also to abstracts 19351, 20853, 20859, and 21209.*

**21236** (CEA-R-4631) STATISTICAL MODEL EVALUATION OF NEUTRON-INDUCED CROSS SECTIONS OF HEAVY NUCLEI FOR ENERGIES IN THE RANGE 3 keV TO 1 MeV. Fission, Radiative Capture, and Inelastic Cross Sections on $^{232}$U, $^{238}$Pu, and $^{240}$Pu Targets. Thomet, P. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Nov 1974. 71p. (In French). Dep. NTIS (US Sales Only) $6.75.

A method is described for a statistical model evaluation of radiative capture, fission and inelastic scattering cross sections for 3 keV to 1 MeV neutrons on heavy nuclei. It consists of the determination of the fission channel characteristics by a least-squares fit to various experimental fission data such as angular distribution of fission fragments, anisotropies, and total fission cross sections. The method combines the use of neutron transmission coefficients from a coupled channel model and calculated penetrabilities for double-humped fission barriers. Results are presented for the nuclei: $^{232}$U, $^{236}$U, $^{238}$Pu and $^{240}$Pu. (auth)

**21237** (ORO-2843-24, pp vp) FRAGMENT NUCLEAR CHARGE STRUCTURE IN THE THERMAL NEUTRON INDUCED FISSION OF $^{235}$U. Muga, L.; Clem, A. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

Through use of a thin film detector to indicate nuclear charge, Z, from measured specific luminescence values, direct evidence was obtained for fragment nuclear charge structure in the thermal-neutron-induced fission of $^{235}$U. The structure, occurring as a preference for formation of alternate Z charge units, is most pronounced for fission events leading to higher total kinetic energy release. (6 figures) (auth)

**21238** (ORO-2843-24, pp vp, Sect.C) NEW STRUCTURE IN MASS AND ENERGY DISTRIBUTIONS OF $^{235}$U (n$_{th}$, FISSION). Clem, A. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

Two new mass and energy fine structure observations in the thermal neutron fission of $^{235}$U are reported. One of the observations is at variance with the Thomas-Vandenbosch hypothesis for such structure. The other shows another possible external result of the deeper operation of two fission modes. (3 figures) (RWR)

**21239** (ORO-2843-24, pp vp, Sect.D) SYMMETRIC TO ASYMMETRIC MASS RATIOS FROM FRAGMENT ENERGY AND

SPECIFIC LUMINESCENCE SPECTRA FOR PROTON-INDUCED FISSION OF $^{232}$Th AND $^{238}$U. Eaker, R. (Florida State Univ., Tallahassee); Plendl, H. S.; Zeller, A. E.; Muga, L.; Clem, A.; Nicovich, J. M. 1974.

In development and applications of thin film detectors.

Excitation functions for proton fission have shown distinct breaks at certain incident proton energies at which values of symmetric-to-asymmetric or peak-to-valley ratios change more or less abruptly. The purpose of this work was to determine the existence and position of these breaks with a more sensitive detector system than previously used. The fission of $^{232}$Th and $^{238}$U induced by 10- to 18-MeV protons was studied. Ratio curves were determined from contour plots of the coincident response of a thin film detector and a solid state detector to the fission fragments. Reaction onsets calculated with a computer program based on a statistical model are compared with the experimental results. (14 figures, 1 table) (RWR)

**21240** (ORO-2843-24, pp vp, Sect.E) EFFECT OF EMISSION ANGLE ON FISSION FRAGMENT SPECTRA. (Florida State Univ., Tallahassee). 1974.

In development and applications of thin film detectors.

Fragment spectra from the proton fission of $^{238}$U and $^{232}$Th at 16.00 MeV were observed, and possible variance in the spectra during variation of the position of the detector for fixed proton energy was investigated. A thin film detector (TFD)–solid state detector (SSD) assembly was used. Spectra were recorded at 140.3°, 113.4°, and 90.0°. No critical difference was seen in SSD fission fragment spectra between 90.0° and 140.3°. In the TFD spectra, however, the light fragment at 90.0° emission was shifted to higher values relative to near 180° emission and indicated higher Z or higher velocity light fragment emission (or both) at 90.0°. Whether the anomaly in the TFD spectrum is only an experimental artifact or truly reflects an angular dependence of the fission fragment spectra will be examined further. (8 figures) (RWR)

**21241** (ZFK-271, pp 182-183) EVALUATION AND PHYSICAL INTERPRETATION OF SYSTEMATIC BEHAVIOR IN FAST NEUTRON DATA. Angeli, I. (Kossuth Univ., Debrecen, Hungary). Feb 1974.

From third international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The systematic behavior in fast neutron data is considered for fission product yields from uranium-238 at 14 MeV, (n,2n) cross sections at 14 MeV, and a semi-classical description of fast neutron cross sections. (JFP)

**21242** PRODUCTION OF PROMPT MUONS BY THE INTERACTION OF 28–GeV PROTONS. Leipuner, L.B.; Larsen, R.C.; Smith, L.W. (Brookhaven National Laboratory, Upton, New York 11973); Adair, R.K.; Kasha, H.; Ankenbrandt, C.M.; Stefanski, R.J.; Wanderer, P.J. Jr. Phys. Rev. Lett. 34: No. 2, 103-106 (13 Jan 1975).

Analyses of measurements of muons produced directly, in the forward direction, by the interaction of 28–GeV protons with uranium show that the muon/pion production ratio for negative particles is $13\times10^{-5}$ for 11.6–GeV particles, $2.6\times10^{-5}$ at 20.3 GeV, $1.3\times10^{-5}$ at 23.5 GeV, and $7.0\times10^{-6}$ at 25 GeV. The largest ratio is similar to ratios measured at higher energies and large transverse momenta, and none of the ratios are easily explained in terms of conventional mechanisms. (auth)

**21243** SHAPE ISOMERS. Poenaru, D. N. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 26: No. 10, 1061-1074 (1974). (In Rumanian).

After a brief review of the techniques used in this field, the methods of investigation and some particular results are presented. Separate sections are reserved for double fission isomers, lifetime systematics, and excitation energy systematics. Some explanations concerning the nature of shape isomers are qualitatively discussed. The 110 references are chronologically ordered. (7 figures, 4 tables) (auth)

## Nuclear Theory

*Refer also to abstracts 20868, 20898, 21085, 21088, 21109, 21115, 21160, 21175, and 21333.*

**21244** (COO-2171-41) POLYNOMIAL EXPANSIONS FOR EXCITATION STRENGTHS. Draayer, J. P.; French, J. B.; Potbhare, V.; Wong, S. S. M. (Rochester Univ., N. Y. (USA). Dept. of Physics and Astronomy; Toronto Univ., Ontario (Canada). Dept. of Physics). 1974. Contract AT(11-1)-2171. 9p. (UR-513). Dep. NTIS $4.00.

Rapidly convergent expansions for the strength function of an excitation in a many-particle model space are given in terms of orthogonal polynomials defined by the state or partial state densities of the system. Convergence is assured in a wide range of circumstances by the operation of a central limit theorem. Level-to-level fluctuations are in many cases small, their automatic elimination in the statistical smoothing generated by truncating the series then leading to only small errors. (auth)

**21245** (COO-3071-111) SHELL MODEL THEORY OF RADIATIVE PION CAPTURE. Vergados, J. D. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). 25 Nov 1974. 71p. Dep. NTIS $6.75.

The formalism for calculating the radiative pion capture cross section was developed for shell model calculations in the impulse approximation. It includes the momentum dependent terms of the effective transition operator. The expressions obtained, for any angular momentum of the pion, are easy to use directly or program for the computer. The giant dipole and giant quadrupole resonances are discussed. The quasifree background is calculated within the framework of the distorted wave impulse approximation. The formalism was applied in the case of $^{16}$O. Very good agreement with experiment is achieved. (auth)

**21246** (HMI-B-153) SEMI-CLASSICAL APPROACH TO HEAVY ION COLLISIONS. Landowne, S. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F.R. Germany). Bereich Kern- und Strahlenphysik). Sept 1974. 30p. Dep. NTIS (US Sales Only) $4.50.

The heavy-ion collisions discussed are elastic scattering proper and inelastic scattering to low-lying collective states. The purpose of the work is to investigate the thesis that "Quantum mechanics is just classical dynamics plus the superposition principle". Strong absorption and rainbow models are described. Angular distributions are calculated for several heavy-ion reactions, with the emphasis on oxygen scattering by $^{58}$Ni. Semiclassical calculations by the saddle point method are also compared with the quantum mechanical results, and the agreement is impressive. It lends support for the thesis enunciated above. (13 figures) (RWR)

**21247** (JINR-E2-8239) ANALYTICITY AND DETERMINATION OF SPIN-ZERO LIGHT NUCLEUS CHARGE RADIUS. Dubnicka, S.; Dumbrais, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 17p. Dep. NTIS (US Sales Only) $4.00.

A new model-independent method of determination of spin-zero light nucleus charge radius is proposed. The method is based on the hypothesis of analyticity of the form factor in the complex momentum-transfer-squared plane. It leads to the most unbiased estimations of the charge radius and of the charge distribution. A possible existence of zeros of the form factor is discussed. The method was illustrated practically in the cases of $e^4$He, $e^{12}$C, and $e^{16}$O elastic scattering. (3 figures, 3 tables) (auth)

**21248** (JINR-E4-8350) MUON CAPTURE PHENOMENOLOGY (SPIN ZERO TARGETS). Oziewicz, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 25p. Dep. NTIS (US Sales Only) $4.25.

The restrictions on the effective muon-nucleus interaction which follow from gamma-neutrino angular distributions (Miller et al.) and recoil nuclear polarization (Possoz et al.) data, reported for the first time for partial muon capture, are considered. Some inconsistencies are pointed out. The maximal information which can be deduced from such experiments (limit on T-violation, two-component theory confirmation, etc.) is studied. (auth)

**21249** (JUL-1005-KP) BRUECKNER THEORY AND DENSITY-DEPENDENT FORCES IN FINITE NUCLEI. Muether, H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Kernphysik; Bonn Univ. (F.R. Germany)). Oct 1973. 107p. (In German). INIS.

Density-dependent effective nuclear forces for finite nuclei are derived from the Brueckner theory without reverting to nuclear matter, as has usually been done so far. For this purpose, the Bethe–Goldstone equation is solved directly for the finite nucleus, and the self-consistency of the Pauli operator is in particular taken into account. The nuclear forces thus obtained are used for the calculation of separation and one-particle energies, and are applied to the nuclei $^{16}$O, $^{12}$C and $^{20}$Ne. (GE)

**21250** (KFK-1850) SINGLE PARTICLE LEVELS AND WAVE FUNCTIONS IN A NILSSON WELL WITH $Y_4$ AND $Y_6$ DEFORMATIONS. Weller, F. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Kernphysik). Oct 1974. 60p. Dep. NTIS (US Sales Only) $6.00.

Single particle energy levels and wave functions in a Nilsson well with $Y_4$ and $Y_6$ deformations are calculated. The Hamiltonian is diagonalized in Nilsson's alternative representation using the Jacobi method. Both the coefficients in the uncoupled and in the coupled representation can be calculated as well as the decoupling factors. For the values 0.2 and 0.3 of the deformation parameter $\epsilon_2$ tables are presented for the Nilsson states which have their leading components in the N = 5,6 and 7 shell. The deformation parameter $\epsilon_4$ is varying from −0.075 to 0.075 in steps of 0.025. For the other parameters the following values were chosen: $\kappa = 0.0635$, $\mu = 0.336$, $\epsilon_6 = 0$. (auth)

**21251** (NP-20283) YEARBOOK, 1973. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica; Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 1973. 247p. (In Dutch). Dep. NTIS (US Sales Only) $15.50.

The organization and purpose of the Foundation for Fundamental Research on Matter (F. O. M.) with its FOM-Institute for Atomic and Molecular Physics in Amsterdam and its FOM-Institute for Plasma Physics at Jutphaas are briefly discussed. The studies in nuclear physics, atomic physics, metals, molecular physics, solid state physics, and high energy physics at Amsterdam and the plasma physics studies at Jutphaas are summarized. An extensive list of publications made in each area is appended. (JSR)

**21252** (ORO-4317-45) SPECIAL EXAMPLES OF QUANTIZED FRICTION. Technical Report No. 75-049. Immele, J. D.; Kan, K. K.; Griffin, J. J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Jan 1975. 38p. Dep. NTIS $5.00.

The nonlinear velocity potential formulation of quantal friction is studied in several special schematic cases: the spreading of a Gaussian packet, superposition of packets, barrier penetration, and potential resonances. Those features which emerge are unified by the concept of a local fluid velocity to which friction is proportional. (auth)

**21253** (RLO-1388-679) PROGRESS REPORT FOR PROGRAM "B," THEORETICAL NUCLEAR PHYSICS PROGRAM. For the Contract Year October 1, 1973–September 30, 1974. (Washington Univ., Seattle (USA)). 1973. Contract AT(45-1)-1388. 45p. Dep. NTIS $5.25.

Research on nuclear reactions, nuclear structure and symmetries, quantum statistical mechanics and many-body problems, field theory and elementary particles, atomic physics, general theory, and astrophysics is summarized. A list of publications is included. (JFP)

**21254** (ZFK-271) PROCEEDINGS OF THE THIRD INTERNATIONAL SEMINAR ON INTERACTIONS OF FAST NEUTRONS WITH NUCLEI, GAUSSIG, 5–9 NOVEMBER 1973. Kiessig, G.; Reif, R. (eds.). (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Feb 1974. 205p. (In English and Russian). (CONF-731154-).

The conference included 35 papers one of which was abstracted previously in NSA as: 30:22925. Separate abstracts were prepared for 34 papers. (JFP)

*For abstracts of individual papers see: 19739, 19808, 21154, 21165, 21166, 21182–21185, 21194, 21203, 21211–21214, 21228, 21229, 21231, 21232, 21241, 21255–21266, 21306, and 21917.*

**21255** (ZFK-271, pp 1-6) NUCLEAR LEVEL DENSITIES. Muenchow, L. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The discussion of nuclear level densities covers theoretical methods and predictions including the noninteracting fermion gas and interacting fermions. Comments are made on the deformation behavior at high excitations. (JFP)

**21256** (ZFK-271, pp 32-37) CONTRIBUTION OF COLLECTIVE MOTION TO THE DENSITY OF EXCITED NUCLEAR STATES. Ignatyuk, A. V. (Physics-Energy Inst., Obninsk, USSR). Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Equations describing the energy of the coherent movement of particles in highly excited nuclei were obtained by means of the two-time Green temperature function uncoupled in the random phase approximation. The contribution obtained to the thermodynamic functions describe the behavior of boson (collective) branches of excitation in nuclei. (tr-auth)

**21257** (ZFK-271, pp 38-39) DE-EXCITATION OF THE COMPOUND NUCLEUS. Decowski, P. (Univ., Warsaw). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The discussion of the compound nucleus covers the decay of the compound nucleus, the emission of gamma quanta, the process of gamma radiation, the role of spin effects, existence of the yrast line, and neutron emission. (JFP)

**21258** (ZFK-271, pp 39-47) PRE-COMPOUND EMISSION IN (n,n′) AND (p,α) REACTIONS. Braga-Marcazzan, M. G.; Milazzo-Colli, L. (CISE, Milan). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

It is shown that the model of pre-compound emission in nuclear reactions in the particular form called the excitation model can be applied to the description of the (n,n′) reactions at 14 MeV neutron energy on nuclei in a large range of masses. It is also shown that this concept can be applied to a number of (p,α) reactions at 20 MeV proton energy on the hypothesis that an α-like cluster exists in the target nucleus and that it can be treated like a free particle. The existence of this alpha-like cluster can be calculated. (JFP)

**21259** (ZFK-271, pp 63-68) ABSOLUTE CALCULATION OF THE EMISSION SPECTRA OF NEUTRONS IN THE FRAMEWORK OF THE PRE-EQUILIBRIUM AND EQUILIBRIUM STATISTICAL MODELS. Zeliger, D. (Technische Univ., Dresden); Zeidel, K.; Toneev, V. D. Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

An approach to the problem of the absolute calculation of pre-equilibrium spectra is proposed. It differs from previous methods in two aspects. First the calculation of the absolute transition probability is made in a modified form which eliminates the necessity of introducing supplementary random factors. Secondly for the calculation of the development history, the compound systems, beginning with compound nuclei with one-particle states and final states, are traced by a Monte Carlo method. The calculated results obtained with this method were compared with experimental values and good agreement was obtained. (JSR)

**21260** (ZFK-271, pp 71-76) INTERPRETATION OF THE NEUTRON INDUCED REACTION CROSS SECTIONS IN TERMS OF THE PRE-EQUILIBRIUM AND COMPOUND NUCLEUS MODELS. Decowski, P. (Univ., Warsaw); Grochulski, W.; Marcinkowski, A. Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The experimental excitation curves for some (n,n′) and (n,p) reactions were compared with the predictions of the preequilibrium and the compound nucleus models. The sum of the preequilibrium and the compound nucleus cross sections describes well the experimental excitation curves in the energy region where the compound theory is not able to reproduce the experimental results. (auth)

**21261** (ZFK-271, pp 127-132) DENSITY MATRIX FORMALISM FOR NUCLEAR REACTIONS. Reif, R. (Technische Univ., Dresden). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The general ideas of the density matrix formalism in nonequilibrium statistical physics may be useful to get some insight in the equilibration process in nuclear reactions and to introduce dynamical effects in the statistical theory of nuclear reactions. These ideas are reviewed. (JFP)

**21262** (ZFK-271, pp 149-155) APPLICATION OF THE STATISTICAL THEORY ON HEAVY ION INDUCED COMPOUND REACTIONS. Iwe, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

It is noted in this review that the application of statistical theory to heavy ion induced compound nucleus reactions provides in many

cases a confirmation of the assumption underlying the theory. The difficulties are pointed out. (JFP)

**21263** (ZFK-271, pp 155-164) MICROSCOPIC DESCRIPTION OF DIRECT INELASTIC NUCLEON SCATTERING AND RESONANCE REACTIONS. Hoehn, J.; Reif, R.; Schmidt, R. (Technische Univ., Dresden). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Some results of recent theoretical nuclear reaction analysis are summarized including the spin-dependent effects in the inelastic nucleon scattering from 2plf nuclei, density-dependent effective forces and inelastic nucleon scattering, and resonance reactions with the continuum shell model. (JFP)

**21264** (ZFK-271, pp 167-172) EFFECT OF DIFFUSE DISTRIBUTION OF NUCLEON DENSITY ON THE MOMENT OF INERTIA OF NUCLEI. Blokhin, A. I.; Ignatyuk, A. V. (Physics-Energy Inst., Obninsk, USSR). Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Calculations of the moments of inertia in which the diffusivity of the distribution of nucleon densities on the nuclear surface was considered were made for saddle configurations determining the fission barrier in the liquid drop model. Resulting corrections to the diffuse boundary reduced by 15 to 20% the absolute value of the effective moment of inertia of the fissioning nucleus. (tr-auth)

**21265** (ZFK-271, pp 173-177) CALCULATION OF GROUP CROSS SECTION FROM A NUCLEAR DATA LIBRARY (NDL). Franke, E. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The application of the results of nuclear physics to the calculation of group cross sections from a nuclear data library is considered. The group constants library including the cross section calculation and interpolation and integration procedures is discussed. (JFP)

**21266** (ZFK-271, pp 178-181) CALCULATION OF RESONANCE CROSS SECTIONS FROM RESONANCE PARAMETERS. Heinzelmann, B. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The resonance structure of the cross sections is understood with the compound nucleus mechanism using the R matrix theory of nuclear reactions. (JFP)

**21267** SOME NOTES ON OPTICAL MODEL CALCULATIONS AT MEDIUM ENERGIES. Ingemarsson, A. (Uppsala Univ.). Phys. Scr.; 9: No. 3, 156-160(Mar 1974).

Different methods of taking relativistic effects into account in optical model calculations using the nonrelativistic Schroedinger equation are described. A simple expression is given for the effect on the optical potential of small changes in the wave number. The effects of these changes on the angular distributions calculated in DWBA or DWIA for inelastic scattering are discussed. (auth)

**21268** POSSIBILITIES IN CALCULATIONS OF STRIPPING FORM FACTORS. Bang, J.; Bunakov, V. E.; Gareev, F. A.; Jamalejev, R. M.; Schulz, H. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Scr.; 10: No. 3, 115-120(Sep 1974).

Approximate equations for stripping form factors are derived in perturbation theory. The expansion into a set of Sturmian functions is suggested for the form factors, thus partly justifying the well depth prescription procedure. Numerical calculations are carried out. The asymptotic behavior of the form factors is discussed. (auth)

**21269** A NUMERICAL COMPARISON OF THREE DIFFERENT APPROACHES TO THE WEAK OR INTERMEDIATE COUPLING MODEL FOR 2 PARTICLE-1 HOLE STATES. Ring, P.; Schuck, P. (Technische Univ. Muenchen, Garching (F. R. Germany). Teilinstitut Theorie im Physik-Department). Z. Phys.; 269: No. 4, 323-331(Sep 1974).

5 figs.; 2 tabs.; 15 refs.; with app.

The secular equation of the usual shell-model approach to 2 particle(p)-1 hole(h) states is transcribed in such a way that it can be viewed as the simultaneous coupling of a hole to a (pp) vibration and a particle to a particle-hole vibration. The resulting diagonalization problem is built up by the subsolutions of the (ph) and (pp) TDA, i.e., no matrix elements of the bare two-body interaction enter the equations. We discuss the mathematical properties of the new equations and compare them to the usually applied formulation of the weak or intermediate coupling model. Finally, we give a numerical study for the low-lying states of negative parity of $^{17}O$. (5 figures, 2 tables) (auth)

**21270** MICROSCOPIC VERSUS MACROSCOPIC DESCRIPTIONS OF THE (p,n) CHARGE-EXCHANGE REACTION. Hoffmann, G. W.; Coker, W. R. (Texas Univ., Austin (USA). Center for Nuclear Studies). Z. Phys.; 269: No. 4, 307-314(Sep 1974).

4 figs.; 1 tab.; 28 refs.

We discuss macroscopic form factors generated by using the Lane equations and microscopic form factors generated by using a complex effective nucleon-nucleon interaction in terms of their similarities, differences, and relative successes in describing experimental data for $^{90}Zr(p,n)^{90}Nb^{A}$ and $^{91}Zr(p,n)^{91}Nb^{A}$ from 22 to 40 MeV. Our conclusions are that the (p,n) cross sections are insensitive to the precise nature of the form factor, so long as it is complex and has an imaginary part which is surface peaked. Such a form factor results from all of the prescriptions we discuss. (4 figures, 1 table) (auth)

**21271** AN EXISTENCE PROOF FOR THE HARTREE-FOCK TIME-DEPENDENT PROBLEM WITH BOUNDED TWO-BODY INTERACTION. Bove, A.; Fano, G. (Bologna Univ. (Italy). Istituto di Fisica); Da Prato, G. (Rome Univ. (Italy). Istituto di Matematica). Commun. Math. Phys.; 37: No. 3, 183-191(1974).

11 refs.

By using fixed point theorems for local contractions in Banach spaces, an existence and uniqueness proof for the Hartree-Fock time-dependent problem is given in the case of a finite Fermi system interacting via a bounded two-body potential. The existence proof for the "strong" solution of the evolution problem is obtained under suitable conditions on the initial state. (auth)

**21272** ON THE SEMICLASSICAL INTERPRETATION OF HEAVY ION REACTIONS. Harney, H. L.; Braun-Munzinger, P.; Gelbke, C. K. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F.R. Germany)). Z. Phys.; 269: No. 4, 339-345(Sep 1974).

5 figs.; 2 tabs.; 14 refs.

The semiclassical interpretation of heavy-ion reactions is discussed. It is found that deflection to negative angles is inconsistent with optical model calculations. Due to the uncertainty principle, trajectories are not well defined if the reaction is localized at the nuclear surface. It is, therefore, suggested that quantum diffraction is the dominating physical process for oscillating heavy-ion transfer reactions. (auth)

**21273** ANGULAR MOMENTUM EFFECTS IN THE PRE-EQUILIBRIUM STATISTICAL MODEL. Oblozinsky, P.; Ribansky, I. (Slovenska Akademia Vied, Bratislava (Czechoslovakia). Fyzikalny Ustav). Acta Phys. Slovaca; 24: No. 2, 103-108(1974).

The role of angular momentum conservation in the pre-equilibrium statistical model is illustrated by the excitation function of the $^{41}K(\alpha,n)$ reaction in the $\alpha$-energy range of 8 to 40 MeV. It was found to be most important for low initial exciton configurations, and to have a similar character to that in the equilibrium statistical model for higher configurations. (auth)

**21274** EFFECT OF SINGLET BREAK-UP STATES IN DEUTERON STRIPPING REACTIONS. Harvey, J. D.; Johnson, R. C. (Univ. of Surrey, Guildford, Eng.). J. Phys., A (London); 7: No. 16, 2017-2028(1 Nov 1974).

The contribution from deuteron break up into spin-singlet, zero relative angular momentum, continuum states to the transition matrix for (p,d) and (d,p) reactions is examined. It is shown how these effects can be incorporated naturally into an adiabatic approach, and results of numerical calculations are presented for some specific reactions. It is found that, within limits set by current knowledge of the isovector spin-orbit component of the nucleon optical potential, the corrections to a theory which neglects singlet break-up states are in general very small. (auth)

**21275** VALUE OF THE SINGLE-PARTICLE POTENTIAL IN THE APPROXIMATE RELATIVISTIC THEORY OF THE NUCLEUS. Krutov, V. A.; Fomenko, V. N.; Savushkin, L. N. (Leningrad State Univ.). J. Phys., A (London); 7: No. 16, 2093-2094(1 Nov 1974).

In this addendum the recalculated values of the spin-orbit potential, the average field and the isobaric-spin potential are presented starting from an approximate relativistic equation for a many-nucleon system. (auth)

# PHYSICS (RADIATION AND SHIELDING)

## Radiation Physics

*Refer also to abstracts 19951, 19960, 19997, and 20073.*

**21276** (ORO-2843-24, pp vp, Sect.F) NEW MODEL DESCRIBING THE ENERGY DEPOSITION PROFILE ALONG THE PATH OF ENERGETIC HEAVY IONS. Muga, M. L. (Univ. of Florida, Gainesville). 1974.

In development and applications of thin film detectors.

It has been found that LET is not a suitable parameter to identify with heavy-ion radiation damage (in a study of specific luminescence induced by heavy ions transiting thin plastic scintillators, the luminescence response was a double-valued function when plotted against dE/dx (LET)); a volume energy transfer (VET) is felt to be a more logical choice. A new approach analogous to that used in thin target nuclear bombardments is outlined from which energy density or VET profiles can be obtained. This model approach is independent of detailed mechanisms of how radiation damage occurs. Application of this approach to the calculation of lethal cell damage is discussed. For the case of specific luminescence response of thin film plastic scintillators, the calculated results were in complete agreement with the experimental data. (9 figures) (RWR)

**21277** THEORY OF ELECTRON SCATTERING BY QUASI-PERIODIC STATIC FLUCTUATIONS IN THE PRESENCE OF ELECTRIC AND MAGNETIC FIELDS. Hsu, W. Y.; Falicov, L. M. (Univ. of California, Berkeley). Phys. Status Solidi (b); 66: No. 2, 639-650(1 Dec 1974).

An extension of the Zener breakdown theory is presented. It corresponds to the case in which the periodic lattice potential is replaced by a quasi-periodic static fluctuation of mean wave vector g. The scattering probability for a wave packet which satisfies the Bragg condition to change its wave vector by g is found to be a constant $Q_0$ much smaller than one for fields up to a very high value $E_0$, and a decay as $Q_0(E_0/E)$ beyond that value. The classical Zener case is obtained as one limit. Extensions to magnetic field induced effects are discussed. (auth)

**21278** METHOD FOR CALCULATING THE ABSORBED DOSE NEAR INTERFACE FROM $^{10}B(n,\alpha)^7Li$ REACTION. Kitao, K. (National Inst. of Radiological Sciences, Chiba, Japan). Radiat. Res.; 61: No. 2, 304-315(Feb 1975).

A simplified method is presented for calculating the absorbed dose delivered from the $^{10}B(n,\alpha)^7Li$ reaction by thermal neutrons in medium near the interface of a boron-containing region and a boron-free one. The method takes into account the contribution of the recoiled lithium particle to the absorbed dose and the variation of LET with charged particle energy. Using "combined LET" values derived from the LET of alpha particle and lithium recoil, so-called geometrical factors for calculating the absorbed dose for plane, spherical, and cylindrical interfaces are presented. The geometrical factor for the cylindrical interface is applied to estimate the absorbed dose in the cerebral vascular wall in the boron neutron-capture therapy of brain tumors in man. (auth)

**21279** FURTHER APPRAISAL OF THE COMPTON SCATTERING METHOD FOR DETERMINING ANATOMICAL CROSS-SECTIONS OF THE BODY. Farmer, F. T.; Collins, M. P. (Newcastle upon Tyne Univ., Eng.). Phys. Med. Biol.; 19: No. 6, 808-818(Nov 1974).

Further experimental work was carried out to determine the practical capabilities of the system. A higher-resolution Ge(Li) detector was used to portray the scattering along the lines of passage of a $^{137}Cs$-$\gamma$ beam, and from these results it was possible to construct density cross-sections of the body. The limitations were shown to be due to (a) signal/noise arising from multiple scattering in the body and (b) resolution, which was governed by the finite beam width and finite aperture needed in front of the crystal. By analyzing the contributions to signal/noise and the causes of deficient resolution, improvements were made, which indicated the performance that may be expected from this technique. Illustrations are given of head and chest phantom cross-sections. A suggested design of a twin-headed machine for clinical use is given. (auth)

**21280** SYSTEMATIC STOPPING CROSS SECTION MEASUREMENTS WITH LOW ENERGY IONS IN GASES. Sidenius, G. (Niels Bohr Institutet, Copenhagen). Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd.; 39: No. 4, 1-32(1974).

Systematic stopping cross sections were measured in methane ($CH_4$) for particles with atomic number $Z_1 \leq 10$. The particle energy ranged from 0.6 up to 120 keV, which means that for heavier particles the energy loss caused by the elastic scattering (nuclear stopping) dominates over the inelastic energy losses (electronic stopping). A definition of the different stopping parameters and an analysis of the possible systematic errors caused by the multiple scattering are given. The results of the measurements are compared with the theory of Lindhard, Scharff and Schiott. (auth)

**21281** ENERGY DISSIPATION BY HEAVY IONS IN COMPOUND TARGETS. Andersen, N.; Sigmund, P. (Univ. of Copenhagen). Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd.; 39: No. 3, 1-45(1974).

The sharing of energy among the constitutents of a polyatomic medium in random atomic collision cascades initiated by heavy atomic particles has been studied theoretically. The main interest was to estimate the significance of possible nonstoichiometric effects as they might be of interest in radiation damage and sputtering. It is assumed that primary and recoiling particles slow down by random collisions, scattering and stopping being described according to the framework of LINHARD, SCHARFF, and coworkers. Collision cascades are characterized quantitatively by the recoil density and the slowing-down density. The former quantity specifies the number and energy distribution of recoil atoms of the various species in a cascade and is of particular interest in radiation damage problems. The latter quantity deals with the number and energy distribution of moving atoms in a stationary state and is of particular interest in sputtering problems. Both quantities are calculated for slowing-down in an infinite medium of uniform composition. The asymptotic expressions at high ion energy as compared to the recoil energy are determined explicitly. Deviations from this asymptotic behavior are studied, too. Nonstoichiometric effects are found in both recoil and slowing-down density, and these effects are determined not only by different binding energies of different atomic species—a key role is played by the mutual partial stopping cross sections of the constituent atoms of the medium. It turns out that deviations from stoichiometric behavior are independent of concentration in case of the slowing-down density, but dependent on concentration in case of the recoil density. (auth)

**21282** TRANSMISSION, ENERGY DISTRIBUTION, AND SE EXCITATION OF FAST ELECTRONS IN THIN SOLID FILMS. Fitting, H. J. (Univ., Rostock, Ger.). Phys. Status Solidi (a); 26: No. 2, 525-535(16 Dec 1974).

The transmission ($\eta_T$) and backscattering ($\eta_R$) of electrons with energies between 0.5 and 4 keV in thin films of Be, Al, Ge, Cu, and Ag, together with their secondary yields ($\delta_T, \delta_R$), were measured with a three-collector system. The SE efficiencies of backscattered electrons were 3 to 15 times greater than those of incident PE. The energy distributions of the transmitted electrons were measured with a spherical retarding field analyzer. Average and most probable energies were obtained. Transmission characteristics could be normalized by the maximal penetration range R and in this way generality is achieved for initial energies up to 1 MeV. (15 figures, 41 references) (auth)

**21283** BUILD-UP MEASUREMENTS IN AIR CAVITIES IRRADIATES WITH 6 MV OR 42 MV X-RAYS. Bojtor, I.; Schnell, P. O. (Karolinska Institute, Stockholm (Sweden). Inst. of Radiation Physics). Acta Biochim. Biophys. (Budapest); 8: No. 1, 69-72(1973).

The authors investigated the electronic build-up effect and its influence on the absorbed dose around an air–tissue interface by $10^{-2}$mm TLD discs in a polystyrene phantom. Measurements were performed in order to verify and extend previous results to other cavities and other photon energies. The air cavity was situated at different depths in the phantom, and the build-up curve in the cavity was well determined. Build-up curves show maxima at different depths depending upon the energy of the irradiation used. The decrease of the absorbed dose at the cavity surface must be taken into consideration in radiotherapy, too. (INIS)

**21284** RADIATION PROTECTION IN FAST NEUTRON THERAPY. Mijnheer, B. J. (Afdeling Radiotherapie, Amsterdam). J. Belge Radiol.; 57: No. 5, 369-375(1974). (In Dutch).

After an introduction, in which different types of neutron sources of interest for radiotherapy are compared with respect to their output, depth dose, and energy spectra, shielding and collimation

properties of neutrons are compared with those of photons. Subsequently special problems associated with neutron producing machines such as risks of T-contamination for D-T generators and activation of materials are discussed. Finally the dosimetric problems are evaluated, where the change in radiation quality in a phantom is indicated, associated with a change in the fraction of the gamma rays to the total dose or a change in the neutron energy spectrum. (auth)

**21285** MONTE CARLO CALCULATION OF LINE-OF-SIGHT PARTICLE ATTENUATION. The Tridimensional Program MERCURE-4. Devillers, C.; Dupont, C. (CEN de Saclay, Gif-sur-Yvette, France). pp 596-610 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The program MERCURE-4 integrates neutron or gamma-ray line of sight point attenuation kernels (biological doses, gamma-heating, ...) by a Monte-Carlo technique in three-dimensional geometrical configurations and in the multigroup approximation. The program calculates and adjusts importance values which it uses for sampling source particles so that the effort of the user not familiar with Monte-Carlo is reduced to a minimum. (FR)

**21286** ANATOMY OF RADIATION TRANSMISSION, DEVELOPED BY A SEMI-ANALYTICAL SIMULATION OF RADIATION TRANSPORT. Biro, G. G. (Gibbs and Hill, Inc., New York). pp 236-252 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A new semi-analytical model to simulate radiation transport, as described by the Boltzmann equation is presented. While a particle was followed from collision to collision, the spatial variable was integrated analytically, and the angular variables were integrated by both conventional and Monte Carlo techniques. The output details the transmission of each order of collision by tracing the contribution of any order of collision in each energy interval in each direction separately. In addition, it integrates the accumulated contribution from the first to each order of collision, thus providing all orders of collision-bound angular and energy spectra. There is no limitation to the calculation of the segregated contribution of any higher order of collision. The output furnishes the whole skeleton of the transmission results as they are built up from their components. (FR)

## Radiation Protection Standards

*Refer also to abstracts 19546, 19561, 19951, 19977, 20094, 21292, and 21884.*

**21287** (DHEW/FDA-75-8010, pp 15-20) FOOD AND DRUG ADMINISTRATION'S REGULATORY PHILOSOPHY AND RESPONSIBILITIES. Gardner, S. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The regulatory philosophy of the US Food and Drug Administration is based on encouraging compliance by informing, cooperation, assisting, coordinating, educating, and communicating rather than writing rules and forcing compliance. One example cited is the Standard for Diagnostic X-ray Equipment first proposed in 1971. This standard is a compendium of substandards embodying at least 20 safety performance requirements that must be met in equipment and major components manufactured after August 1, 1974. Important input was received from scientists, industry, and the States. To familiarize the persons affected with the new standard, training workshops were held in various parts of the US. To monitor compliance with this standard as many as 50,000 assembler data forms must be processed annually and a fully automatic data storage and retrieval system was developed. Among other advantages, this system will help technical personnel to identify components likely to be out of compliance and thus result in enforcement of the standard with a minimum of inspection. (CH)

**21288** (DHEW/FDA-75-8010, pp 21-23) AEC RELATIONS WITH THE STATES. Muntzing, L. M. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The need for cooperation among Federal and State agencies in the regulation of nuclear power plants to assure the public that the radioactivity generated will not adversely affect health and safety, that the plants will not adversely affect environmental quality, that the plants and their fissionable material will be safeguarded against antisocial behavior, and that the utilities involved will conform to the Nation's antitrust laws is discussed. It is pointed out that regulatory responsibility for nuclear power plants cannot be dispatched merely by licensing reviews, but there must be continual regulatory surveillance over each plant during the time it operates. (CH)

**21289** UNCHANGING ASPECTS OF RADIATION EXPOSURE LIMITS. Meinhold, C. B. (Brookhaven National Lab., Upton, NY). pp 109-116 of Population Dose Evaluation and Standards for Man and his Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

Beginning with the introduction of the first formal recommendation on radiation protection practices, a series of revisions in recommended standards has occurred. A review of the influences and pressures on the scientific community as a whole, and therefore, on the standards setters may provide some valuable insight into the standard-setting process. The introduction of the hot cathode x-ray tube coupled with the public outcry over the battlefield x-ray casualties during World War I provided the needed impetus for the formal adoption of that first "standard." In the mid-1920s Mutscheller developed the recommendation of $1/100$ of the erythema dose in 30 days. This led directly to the first internationally accepted limit of 0.2 R/d and later to 0.1 R/d. Even the 1950 limit of 300 mrem/week for organs at 5 cm in tissue and 600 mrem/week limit for skin had a strong basis in the original Mutscheller work. By the late 1950s the public and scientific debate over the fallout controversy ultimately led to a review of the available radiobiological data by the National Academy of Sciences in the USA and the Medical Research Council in Great Britain. The reports of these committees led the ICRP and the NCRP to the present limits of 5(age-18) rem for certain critical tissues and 15 rem/a for others. Since 15 rem/a is 300 mrem/week, the tie to 1925 is intact. Today the scientific and public debate is over nuclear power plant effluents. Again, as in the 1950s the National Academy of Sciences initiated a review of the available radiobiological data. Concurrently the United Nations Scientific Committee on the Effects of Atomic Radiation performed a similar study. Both reviews were published in 1972. By early 1974 the NCRP had not changed its basic recommendations. The ICRP, after an extensive review issued a press release in 1972 stating that no changes in the radiation protection standards are warranted. (auth)

**21290** BRITISH COMMITTEE ON RADIATION UNITS AND MEASUREMENTS. Jennings, W. A. Radiol. Prot. Bull.; No. 9, 23-26 (Oct 1974).

The history of the development of the standardization of ionizing radiations is summarized in two sections. The years 1913 to 1966 are briefly and chronologically surveyed, and then follows a description of the reconstitution in 1966 of the "British Committee on Radiation Units and Measurements", together with its terms of reference. The subsequent achievements of this committee in the definition and standardization of radiation units, and the calibration of dosemeters, are described. (UK)

**21291** SI UNITS. Ramsey, N. W. (Charing Cross Group of Hospitals, London); Day, M. J. Brit. J. Radiol.; 47: No. 563, 821-822 (Nov 1974).

Discussion over the names and sizes of the radiation SI units continues in the first letter with consideration of the SI unit of exposure. This had previously been described as "incorrect" (Ramsey, N. W., 1974, British Journal of Radiology, 47, 296), as a result of the use of the word "exposure" in a general sense by workers in the radiation field, whereas this concept is now defined as energy fluence. For standardization purposes exposure has been defined by reference to the ionization produced in air, thereby restricting the use of the word. It is suggested that the previously proposed names of "new curie" and "new rad" should not invite error, as the smallest difference in magnitude between the existing and proposed new units would be by an order of two. The second letter indicates that the problems arising in radiology from non-specific names of the SI units could be overcome by retaining specific names for radiological physical concepts such as absorbed dose, exposure and activity, whilst adopting the SI units of measurement. Difficulties resulting from the size of the units could be minimized by using macroscopic or microscopic units as appropriate, and in particular by adopting the mole as the unit of substance; the SI unit of activity would then be the mole per second. (UK)

# Radiation Source Calibration and Standardization

**21292** (DHEW/FDA-75-8010, pp 171-187) REVIEW OF ANSI NUCLEAR STANDARDS ACTIVITIES. Coleman, J. R. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The functions of the Nuclear Technical Advisory Board of the American National Standards Institute are reviewed. A list of nuclear standards developed to date is included and current standards development projects are discussed. (CH)

# Shielding Calculations and Experiments

*Refer also to abstracts 21349–21351, 21375, 21392, 21393, 21396, 21398, 21399, 21408, 21429, 21430, 21432, 21434, 21473–21475, and 21758–21760.*

**21293** EUROPEAN SHIELDING INFORMATION SERVICE. Nicks, R.; Ponti, C. (Commission of the European Communities, Ispra, Italy). pp 226-233 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

ESIS is a new analysis and information Center on shielding. It was organized at the beginning of 1972 at the Joint Research Center of Ispra (Italy). The reasons that have led to the creation of this information Center, and its program, are given. (FR)

**21294** RADIATION SHIELDING INFORMATION CENTER (RSIC), A UNIFYING FORCE IN THE INTERNATIONAL SHIELDING COMMUNITY. Maskewitz, B. F.; Trubey, D. K.; Roussin, R. W.; Clark, F. H. (Oak Ridge National Lab., TN). pp 215-225 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The Radiation Shielding Information Center is a technical institute serving the international shielding community. It acquires, selects, stores, retrieves, evaluates, analyzes, synthesizes and disseminates information on shielding and ionizing radiation transport. Computer codes and computer-readable nuclear data are treated as an integral part of this work. Problems which hinder code exchange are alleviated by scientists making new development available and therefore open the scrutiny and improvement. Through free and open exchange of shielding information the entire international shielding community can progress rapidly as a unit to advance the state of the art. (FR)

**21295** SHIELD: A MONTE CARLO PROGRAM TO STUDY NEUTRON TRANSPORT IN SLAB GEOMETRIES USING A PDP-9 COMPUTER. Adams, R. J.; Henry, L. C.; Lokan, K. H. (National Research Council of Canada, Ottawa). pp 434-441 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

SHIELD, which makes extensive use of core overlays, is a Fortran IV program, modelled on 05R, which is designed to run on a 16K Digital Equipment Corporation PDP-9 computer. The creation and analysis of a collision tape (10,000 collision histories) takes 90 minutes/cycle, and after each cycle the updated output is preserved, so that the program may be restarted with a minimum of loss. (FR)

**21296** DISCRETE ORDINATES-NUMERICAL INTEGRATION METHOD FOR NEUTRON TRANSPORT EQUATION IN ONE AND TWO DIMENSIONAL GEOMETRIES. Takeuchi, K.; Yamaji, A. (Ship Research Inst., Tokai, Japan). pp 339-354 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A numerical approach to the Boltzmann transport equation is presented for practical calculations of the neutron penetration. The scattering integral, with anisotropic treatment of elastic scattering and isotropic treatment of inelastic scattering, is numerically evaluated. A system of coupled one-group integral equations, converted from the energy-dependent transport equation, is calculated by performing line integration along the neutron flight path. Comparisons are given of the calculated results with experimental angular spectra in graphite and water, and with experimental reaction rates in iron-water. (FR)

**21297** INTERACTIVE COMPUTER GRAPHICS APPLIED TO SHIELD DESIGN. Goddard, A. J. H.; Wrigley, M. F. (Imperial Coll. of Science and Tech., London). pp 442-455 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A study is reported of the use of interactive computing techniques, together with the use of a visual display unit, in shield design. The particular application is to the design of cells containing gamma-ray sources. Experimental measurements are also reported which were made in a cell/labyrinth configuration with the object of evaluating the model used to represent gamma-ray streaming. (FR)

**21298** SOLUTION OF THE COUPLED INTEGRAL AND DIFFERENTIAL FORM OF THE TRANSPORT EQUATION USING A LEGENDRE POLYNOMIALS SOURCE DENSITY APPROXIMATION IN ANGLE AND SPACE FOR SLAB GEOMETRY. Stepanek, J.; Ligou, J. (Eidgenoessisches Inst. fuer Rekktorforschug, Wuerenlingen, Switzerland). pp 302-338 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

Neutron source density approximation in angle and space using a Legendre polynomial expansion are used for solving the integral transport equation in one-dimensional multilayer slab geometry. Different expansions are used for each layer. The number of integral equations is limited because a set of differential equations is used at the same time. The SHERLOCK code based on this method was written mainly for shielding problems, but reactor or cell calculations are also possible. Several numerical applications are given: neutron spectra in light water, neutron penetration in iron-water shieldings, etc. (FR)

**21299** NEW MODIFICATIONS OF THE MONTE CARLO METHOD FOR USE IN CALCULATING DIFFERENTIAL CHARACTERISTICS OF THE GAMMA RAY FIELD OUTSIDE REACTOR SHIELDING. Viktorov, A. A.; Zolutukhin, V. G.; Klimanov, V. A.; Kochanov, V. A.; Ksenofontov, A. I.; Mashkovich, V. P.; Orlov, N. Yu.; Panchenko, A. M.; Sinev, V. N. (State Committee for Research in Atomic Energy, Obninsk, USSR). pp 355-394 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In English and Russian).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The characteristics of the gamma ray field created by plane sources with energies ranging from 0.145 to 7.0 MeV outside uniform and non-uniform slabs are studied; modifications are developed for Monte Carlo calculations. The minimum variance method, a variant of the exponential transformation technique, and the parametric method, when applied with a computer, make it possible to calculate radiation fields over large thicknesses and in shielding containing irregularities. (FR)

**21300** MOMENTS METHOD CALCULATIONS OF NEUTRON AND GAMMA-RAY PENETRATION IN BULK MEDIA. Simmons, G. L. (Babcock and Wilcox Co., Lynchburg, VA); Eisenhauer, C.; Spencer, L. V. pp 268-283 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A system of computer codes using the moments methods to calculate penetration of neutrons and gamma rays in bulk media is described. Results are presented for the penetration of fission neutrons incident at various angles on concrete. The use of adjoint procedures for calculating gamma ray buildup factor data is also described and results are presented for the penetration of gamma rays from point sources emitting at various conical angles in a concrete medium. Finally, the two types of calculations are combined to produce data for penetration of gamma rays produced in concrete by a neutron source. (FR)

**21301** APPLICATIONS OF THE TRANSMISSION MATRIX METHOD IN GAMMA-RAY SHIELDING ANALYSIS. Rohach, A. F. (Iowa State Univ. of Science and Tech., Ames). pp 253-267 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The transmission matrix method has been applied to various gamma ray shielding problems. The transmission matrix for plane geometry analysis has been used to develop a point geometry matrix kernel. The point kernel has been investigated for shielding slabs of two or more materials. Various types of shielding configuration using surface sources, volumetric sources, and exponential secondary sources also have been investigated. Results have been compared with previous published works and other computations using scalar point kernel and buildup factor analyses. (FR)

**21302** TRIPOLI, A THREE-DIMENSIONAL POLYKINETIC PROGRAM. Bourdet, L.; Katz, S.; Nimal, J. C.; Vergnaud, T. (CEN de Saclay, Gif-sur-Yvette, France). pp 284-301 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The Monte-Carlo program TRIPOLI calculates the energy and space distribution of neutron fluxes and currents in general three-dimensional geometries. The biasing techniques which are introduced allow the treatment of neutron penetration problems through large thicknesses of materials within reasonable calculation times. A number of examples of applications of the program are given. (FR)

**21303** SPECIAL PROPERTIES OF SHIELDING CONCRETES ACTING ON THE PROCESSES OF RADIATION ATTENUATION. Dubois, F. (CEN de Saclay, Gif-sur-Yvette, France). pp 682-701 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The use of concrete as shielding material in nuclear reactors has shown that a better knowledge of its nature could, in an important way, improve results of radiation attenuation calculation. Hydrogen and some absorbent materials of slight ponderable importance as well as the knowledge of the evolution of water contents in hydraulic binders and aggregates play a preponderant part in the choice of concretes. Studies made by C. E. A. of the different kinds of special shielding concrete as a function of temperature, concrete thickness, its mineralogical composition, favored the wide use of these materials in reactor shielding. A synthesis of all the work done by C. E. A. in order to obtain particular properties for the shielding material is given. (FR)

**21304** MODIFIED FORM OF DIFFUSION THEORY FOR USE IN CALCULATING NEUTRON PENETRATION IN PRACTICAL SHIELDS. Bendall, D. E. (UKAEA Reactor Group, Winfrith, Eng.); Cripps, S. J. pp 501-537 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A rapid survey method for bulk shield analysis is proposed as an alternative to the well known neutron removal-diffusion method. Two variants are described, one using the multigroup diffusion equations with a true first flight correction, and the other using the multigroup equations alone; this latter form without the kernel integration offers worthwhile savings in computer costs. A feature of the method is the adjustment of the diffusion coefficients so that very close agreement is achieved with Monte Carlo reference calculations for simple one-dimensional slabs. A series of tests confirming the validity of the use of the adjusted parameters in more general shielding situations is described. The application to gamma-ray shielding is also considered. (FR)

# PHYSICS (THEORETICAL)

## General

*Refer also to abstracts 21253 and 21922.*

**21305** (ITEF-40) CONVERGENCE TO THE NORMAL SUM RULE OF RANDOM NUMBER OF RANDOM COMPONENTS. Pechinkin, A. V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 8p. (In Russian). INIS.

The series of sums of independent, homogeneously distributed, random terms up to a random index not depending on the terms is considered. Necessary and sufficient conditions are presented for convergence to a normal sum value. (tr-SJR)

**21306** (ZFK-271, pp 119-126) STATISTICAL MECHANICS OF NONEQUILIBRIUM. Roepke, G. (Technische Univ., Dresden). Feb 1974.

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

The treatment of nonequilibrium statistical mechanics includes some general aspects of statistics, the master equation, the method of Bogoliubov, the nonequilibrium statistical operator of Zubarev. (JFP)

**21307** EXPERIMENTAL TEST OF GRAVITATIONALLY INDUCED QUANTUM INTERFERENCE. Overhauser, A.W.; Colella, R. (Department of Physics, Purdue University, West Lafayette, Indiana 47907). Phys. Rev. Lett. 33: No. 20, 1237-1239 (11 Nov 1974).

We call attention to a feasible laboratory experiment with an outcome that depends necessarily on both Planck's constant and the gravitational constant. A neutron interferometer for which the two beams enclose an area of $\sim 6$ cm$^2$ be cut from a single crystal of silicon. A shift of $\sim 10$ fringes is anticipated when the interferometer is rotated 180° about an axis parallel to both the earth's surface and the incident neutron beam. (auth)

**21308** MACHINE INDEPENDENT MONTE CARLO EVALUATION OF THE PERFORMANCE OF DYNAMIC STOCHASTIC SYSTEMS. Senne, K. D. (Massachusetts Inst. of Tech., Lexington). Stochastics; 1: No. 3, 215-238(Sep 1974).

The familiar subject of Monte Carlo analysis is reviewed, with special emphasis on reproducibility of results, regardless of the digital computer employed. A digital pseudo-random number generator is introduced and tested for desirable characteristics. The generator procedures 36-bit random numbers, and a method of segmenting the modular arithmetic is described which allows for the exact reproduction of the sequence of any binary machine, independent of the word length. (3 figures, 14 tables) (auth)

**21309** CANONICAL TRANSFORMATION AND ACCIDENTAL DEGENERACY. III. A Unified Approach to the Problem. Moshinsky, M.; Patera, J.; Winternitz, P. (Univ. of Montreal). J. Math. Phys. (N. Y.); 16: No. 1, 82-92(Jan 1975).

The discussion of the groups of canonical transformations responsible for accidental degeneracy in quantum mechanical problems is continued. A general unified treatment is provided for a wide class of two-dimensional physical systems, having an energy spectrum which is a linear combination of two quantum numbers. The general method involves the use of both non-orthonormal and orthonormal sets of states to construct groups of complex or real canonical transformations, mapping the problem under consideration onto the two-dimensional isotropic harmonic oscillator. The group responsible for the accidental degeneracy is then quite obviously SU(2). The problem of an isotropic oscillator in a sector $\pi/q$ (q integer) was discussed previously using a nonorthonormal basis. The analysis is carried out in an orthonormal basis to establish the general procedure mentioned above. Also the Calogero problem is analyzed in detail for three particles which has a spectrum of the type given above, and explicitly the canonical transformation that maps it on the anisotropic oscillator whose ratio of frequencies is 2/3 and subsequently on the isotropic one is obtained explicitly. (auth)

**21310** QUANTUM MECHANICS OF DISSIPATIVE SYSTEMS AND NONCANONICAL FORMALISM. George, C.; Prigogine, I. (Univ., Brussels). Int. J. Quant. Chem., Symp.; No. 8, 335-346 (1974).

From international symposium on atomic, molecular, solid-state theory, and quantum statistics; Sanibel Island, Florida (20 Jan 1974).

A noncanonical transformation theory of large dynamical systems is presented that leads to a formulation of dynamics in terms of processes, in which the concepts of well defined "units" and "interactions" can be simultaneously accommodated. (auth)

**21311** CONTRIBUTION OF MULTI-EXCITATION PROCESSES TO THE EQUILIBRIUM PROPERTIES OF MANY-BOSON SYSTEMS. Family, F. Worcester, MA; Clark Univ. (1974). 127p. University Microfilms Order No. 75-4280.

Thesis (Ph. D.).

A diagrammatic field theoretical formulation based on the dielectric function, a collective coordinate approach, and the method of correlated basis functions is applied to a rigorous microscopic study of the contribution of multi-excitation processes to the equilibrium properties of many-Boson systems at zero temperature. Explicit expressions for the excitation spectrum, the static and dynamic structure functions are obtained to first order beyond the Bogoliubov approximation. The results are systematically applied to two specific models: a high-density charged Bose gas and a dilute Bose gas with a short-range potential. (Diss. Abstr. Int., B)

**21312** ANALYTICAL LEAST SQUARES SOLUTION APPLIED TO SPECTRAL SERIES LIMIT DETERMINATIONS. Delamater, N. D.; Collins, G. W.; Newsom, G. H. (Ohio State Univ., Columbus). J. Quant. Spectrosc. Radiative Transfer; 14: No. 12, 1345-1350(Dec 1974).

A method is derived to determine spectral series limits analytically. It is assumed that the graphical quantum defect solution ($n - n^*$ vs $\nu_{lim} - \nu$) is approximately linear (for the correct $\nu_{lim}$) so that a least-squares fit may be obtained. The problem reduced to a non-linear system of three equations in three unknowns (two least-squares coefficients and the series limit) with a unique solution found numerically. Least-squares errors are also obtained for each variable. Results using this method agree well with published values obtained by the traditional graphical method. This procedure provides an operational method for series-limit determinations, independent of the subjective problems involved with the graphical method. (auth)

**21313** HAMILTONIAN AND GENERATING FUNCTIONAL FOR REPRESENTATIONS OF A NON-RELATIVISTIC LOCAL CURRENT ALGEBRA. Menikoff, R. S. Philadelphia; Univ. of Pennsylvania (1974). 130p. University Microfilms Order No. 75-2759.

Thesis (Ph. D.).

The nonrelativistic current algebra with conserved current consisting of $\rho(x)$, the particle number density and J(x), the flux density of particles, is studied. The Hamiltonian for any time reversal invariant system of spinless particles is expressed as a hermitian form in the currents. This leads to a functional equation determining the generating functional which specifies a representation of the current algebra in which the Hamiltonian is well defined. In the N/V limit an expression for the generating functional in terms of correlation functions is given. Representations of the current algebra which are translation invariant, satisfy the cluster decomposition property and which have different Hamiltonians are shown to be inequivalent. Examples are given corresponding to the N/V limit of a free Bose gas, Bose gas in an external potential, free Fermi gas and Bose gas (in one dimension) with the two body interaction potential $V(x) = 2/x^2$. A classical statistical mechanics analog is given for the last example. (Diss. Abstr. Int., B)

## Quantum Field Theories

*Refer also to abstracts 21028, 21098, and 21253.*

**21314** (JINR-P2-8415) REPRESENTATIONS OF CURRENT ALGEBRA IN THE SPACE OF ASYMPTOTIC FIELDS AND SEMILEPTONIC PROCESSES. Dao Vong Dyc; Nguyen Van Hieu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Some experimental consequences of the scheme of realizing the irreducible representations of the SU(6) × SU(6) current algebra proposed in previous work are derived. These consequences display themselves in the semileptonic processes at some definite kinematics. (auth)

**21315** GELL-MANN-LOW EQUATION AND ON-MASS-SHELL AMPLITUDES. Creutz, M.; Wang, L. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 10: No. 11, 3749-3753 (1 Dec 1974).

We show how, in certain theories, the Gell-Mann-Low renormalization-group equation can be applied to physical on-mass-shell amplitudes. These theories are characterized by a selection rule softening the zero-mass singularities in external mass channels. Physical amplitudes asymptotically reflect the anomalous dimensions of the theory. In particular, this analysis provides a field-theoretical argument for a connection between the asymptotic behavior of elastic amplitudes at fixed angle and the electromagnetic form factors. This connection is similar to that proposed by Wu and Yang. (auth)

**21316** SOME SIMPLE VACUUM-POLARIZATION PHENOMENOLOGY: $e^+e^- \to$ HADRONS; THE MUONIC-ATOM X-RAY DISCREPANCY AND $g_\mu - 2$. Adler, S.L. (National Accelerator Laboratory, Batavia, Illinois 60510 and The Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 10: No. 11, 3714-3728 (1 Dec 1974).

We give a simple phenomenological analysis of hadronic and electronic vacuum-polarization effects. We argue that the derivative of the hadronic vacuum polarization, evaluated in the spacelike region, provides a useful meeting ground for comparing $e^+e^- \to$ hadron annihilation data (assumed to arise from one-photon annihilation) with the predictions of parton models and of asymptotically free field theories. Using dispersion relations to connect the annihilation and spacelike regions, we discuss the implications in the spacelike region of a constant $e^+e^-$ annihilation cross section. In particular, we show that a flat cross section between $t = 25$ and $t = 81$ $(GeV/c)^2$ would provide strong evidence against a precociously asymptotic "color" triplet model for hadrons. We then turn to a consideration of the apparent discrepancy between observed and calculated muonic-atom x-ray transition energies. Specifically, we analyze the hypothesis of attributing this discrepancy to a deviation of the asymptotic electronic vacuum polarization from its expected value, a possibility which is compatible with all current high-precision tests of quantum electrodynamics. Under the additional technical assumption that the postulated discrepancy in the electronic vacuum-polarization spectral function increases monotonically with t, the hypothesis predicts a decrease in the expected value of the muon-magnetic-moment anomaly $a_\mu = (1/2)(g_\mu - 2)$ of at least $-0.96 \times 10^{-7}$, which should be detectable in the next round of $g_\mu - 2$ experiments and which is substantially larger than likely uncertainties in the hadronic contribution to $a_\mu$. By contrast, postulating a weakly coupled scalar boson $\phi$ to explain the muonic-atom discrepancy would imply a (very small) increase in the expected value of $a_\mu$. Both the vacuum-polarization and scalar-boson hypotheses (for $M_\phi \geq 1$ MeV) predict a reduction of order 0.027 eV in the $2p_{1/2}-2s_{1/2}$ transition energy in $[^4He, \mu]^+$, an effect which may be observable. (auth)

**21317** SPACE-TIME APPROACH TO ANOMALIES IN THE W-T IDENTITIES AND COMMUTATORS. Nakazawa, N.; Yamada, M. (Univ. of Tokyo). Ann. Phys. (N. Y.); 87: No. 2, 457-469 (Oct 1974).

The Ward-Takahashi identities of the axial-type n-point functions are analyzed, assuming the conformal invariance and the chiral SU(3) × SU(3) symmetry to become exact at the short distance. The anomalies in the identities are obtained in a simple nonperturbative way, and the commutator anomalies are determined in connection with the pinching mechanism in taking the equal-time limit of commutators. (auth)

**21318** ENERGY-MOMENTUM TENSOR IN SCALAR AND GAUGE FIELD THEORIES. Freedman, D. Z.; Weinberg, E. J. (Inst. for Advanced Study, Princeton, NJ). Ann. Phys. (N. Y.); 87: No. 2, 354-374 (Oct 1974).

A previous study of the energy-momentum tensor in $\phi^4$ theory and spontaneously broken non-Abelian gauge field theories is extended here to show finiteness to all orders in perturbation theory. Divergences of Green's functions $\Gamma^{(j)}_{\mu\nu}(q; p_1,\ldots,p_j)$ involving the energy-momentum tensor $\theta_{\mu\nu}$ and j particle fields are removed by counterterms of the ordinary Lagrangian plus a renormalization of the coefficient of the Callan-Coleman-Jackiw improvement term in $\theta_{\mu\nu}$. Physically the extra renormalization means that the mean square "mass radius" of elementary spin zero particles must be specified from experiment. (auth)

**21319** ON SOME NONLINEAR EVOLUTION EQUATIONS IN QUANTUM FIELD THEORY. Tesei, A. (Univ., Paris). J. Math. Phys. (N.Y.); 16: No. 1, 140-146 (Jan 1975).

The field equations of a fermion field with a scalar self-interaction are studied in a three- and four-dimensional space-time. The Faedo-Galerkin method is used to prove the existence of a sequence of approximated solutions which converges in a suitable topology. In a different topology, the existence and uniqueness of a local solution is proved using the contraction principle. (auth)

**21320** GAUGE GROUP AND EXTENSIONS OF POINCARE GROUP. Rideau, G. (Univ., Paris). Phys. Scr.; 9: No. 3, 163-172 (Mar 1974).

In order to unify in a single invariant group of the quantum electrodynamics the Poincaré group and the gauge group, some types of topological extension of the Poincaré group by the gauge group, seen as the additive group of an Hilbert space where is realized the representation of mass zero and spin zero of the Poincaré group is studied. It is shown that the semi-direct product is the only possible extension. (auth)

**21321** CRITICAL BEHAVIOR OF EFFECTIVE POTENTIAL FOR DYNAMICAL-SYMMETRY BREAKING. Wada, H. O. (Univ. of Tokyo). Lett. Nuovo Cim.; 11: No. 16, 697-701 (21 Dec 1974).

The effects of finite temperature on spontaneous symmetry breakings in relativistic field theories were recently shown. It was also shown that symmetries broken at zero temperature are restored above certain critical temperatures. It is shown that there is a critical temperature in the two-dimensional model of a massless N-component fermion field with quartic coupling. (JFP)

**21322** CONSTRUCTION OF A FINITE ENERGY MOMENTUM TENSOR. Clark, T. E. New York; New York Univ. (1974). 141p. University Microfilms Order No. 74-29,962.

Thesis (Ph. D.).

The problem of expressing the energy momentum tensor in quantum field theory in terms of products of point split field operators in a suitable limit is treated. This is an extension of the work done previously on the form of current operators and field equations. The investigation will take place in the framework of Bogoliubov-Parasiuk-Hepp-Zimmermann renormalized perturbation theory. This method is explicitly applied to the scalar $A^4$ self interacting model and pseudoscalar meson-nucleon model. Unfortunately not all models have a bilinear normal product basis for the desired space and an alternative method is needed. This second approach is similar to the first in that it uses the Wilson expansion of more than bilinear point split products of field operators to define the local normal products. The derivation of the Zimmermann identity for the generalized multilocal normal product of four field operators is carried out in the scalar $A^4$ model. The Wilson short distance expansion for the point split product of the four field operators is then shown to follow from the Zimmermann identity. Thus this result combined with the bilinear expansions can be generalized to express the energy momentum tensor in terms of point split products of field operators in a suitable limit in any model. (Diss. Abstr. Int., B)

**21323** PROTON STRUCTURE AND THE LAMB SHIFT IN HYDROGEN-LIKE ATOMS. Gajzago, E. (Eotvos Lorand Tudomanyegyetem, Budapest (Hungary). Atomfizikai Tanszek). Acta Phys. Slovaca; 24: No. 1, 30-39 (1974).

From elementary particle physics seminar; Pezinska Baba, Czechoslovakia (16 Oct 1972).

The present state of the Lamb shift in hydrogen and muonic hydrogen is briefly reviewed. Particular attention is paid to contributions by polarizability of the proton and to the structure of the proton as revealed by recent experiments concerning deep inelastic electron-proton scattering. (auth)

**21324** RENORMALIZATION AND SCALING BEHAVIOR OF EIKONAL PERTURBATION THEORIES. Din, A. M. (Chalmers Univ. of Tech., Goteborg); Nielsen, N. K. Lett. Nuovo Cim.; 12: No. 1, 9-15 (4 Jan 1975).

Some observations on the renormalization and scaling behavior of the charged-particle propagator in scalar quantum electrodynamics are recorded in the ordinary eikonal approximation as well as in the eikonal perturbation theory considered previously. The conclusions indicate that scaling behavior is not realized in the simple sense as anticipated. The field theory to be considered is that of a charged scalar particle (referred to as an electron) interacting with a quantized radiation field, where vacuum polarizations are neglected. (JFP)

**21325** VACUUM POLARIZATION IN NONPOLYNOMIAL QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES. Wataghin, A.; La Camera, M. (Univ., Geneva). Lett. Nuovo Cim.; 12: No. 1, 19-22 (4 Jan 1975).

General nonpolynomial modifications to high energy quantum electrodynamics of the type $L_{e.m.} = -i\bar{L}e\gamma_\mu A^\mu F(\lambda_l, \phi_l)L$ are considered, where the function $F(\lambda_l, \phi_l)$ is nonpolynomial in the new fields $\phi_l$. These fields labeled by the index l represent particles of different mass and spin, the constants $\lambda_l$ being adiabatically

switched on at suitable energies. The simplest nonpolynomial interactions $F(\lambda_1,\phi_1) = \exp[\lambda\phi]$ is considered as a working example, where $\phi$ is a free scalar of pseudoscalar massive field. The correspondingly modified photon propagator is evaluated. As a consequence of the nonpolynomial interactions with the physical vacuum, it is shown that the photon acquires a finite nonzero rest mass. (JFP)

**21326** GAUGE-INVARIANT RENORMALIZATION THROUGH MASS DIFFERENTIATION. Mercaldo, L. (Univ., Salerno, Italy). Lett. Nuovo Cim.; 12: No. 1, 23-29(4 Jan 1975).

A new simple renormalization method is proposed which is a good candidate for preserving symmetries. The procedure to determine the finite part of a divergent Feynman integral is summarized as follows: introduce some auxiliary masses in an appropriate way, differentiate with respect to these masses up to orders generic but high enough to obtain a regularized expression, and go back to the physical situation. (JFP)

**21327** ZAKLADNI POZNATKY TEORIE RELATIVITY. (Principles of Relativity Theory). Fuka, J. Prague; Statni pedagogicke Nakladatelstvi (1973). 148p.

Information is given in a popular manner on the basic knowledge of the Einstein special relativity theory. It is completed with an explanation of the mechanical principle of relativity and a note on the general relativity theory. The interpretation of the basic knowledge of the special relativity theory is based on the interpretation of the Michelson experiment. For clarification, examples of calculations are included in the text. (INIS)

**21328** COVARIANT FIELDS: POINCARE GROUP REPRESENTATIONS AND METRIC STRUCTURE IN THE SPACE OF QUANTUM STATES. Mathews, P. M. (Univ., Madras). Pramana; 3: No. 4, 261-276(Oct 1974).

The representations of the Poincaré group realized over the space of covariant fields transforming according to any irreducible representation $D^{m,n}$ of the Lorentz group are constructed explicitly with reference to a helicity basis. The representation is indecomposable in the massless case. The form of this representation together with the invariance of two-point Wightman functions of the field (which follows from a weak set of axioms) determines the metric structure in the space of quantum states of the field. This structure is explicitly determined for general $D^{m,n}$. Certain particular cases (especially the symmetric traceless tensor field) are discussed in detail. Finally one considers the representation pertaining to massive fields, and examines the passage to the limit of vanishing mass. A limiting procedure is presented which leads from the unitary representation of the massive field to the indecomposable nonunitary representation of the massless field. (auth)

**21329** LAGRANGIAN QUANTUM THEORY. III. Coordinate-free Formulation. Bloore, F. J.; Routh, L. (Univ. of Liverpool). J. Phys., A (London); 7: No. 15, 1829-1839(11 Oct 1974).

It is shown that the Fréchet derivative, which was previously used (Nucl. Phys.; B59: 348 (1973)) to formulate a quantum-mechanical version of Hamilton's principle of stationary action, suffers from certain defects. The algebra of quantum observables is a quotient algebra of a free algebra of coordinate and momentum observables by its ideal generated by the canonical commutation relations. A Fréchet derivative $\delta_X$ is well defined on the free algebra but passes to the quotient only if its associated vector field X is a parallel vector field. It is shown that the apparently consequent restriction of the class of allowable variations in the action principle to parallel vectors may be avoided by defining the variations directly on the quotient algebra. It is then not usually possible to use the notation of the Fréchet derivative. A simpler, coordinate-free, formulation of quantum mechanics is set up based on the Lie algebra of symmetric contravariant tensor fields on the configuration manifold of the system and the principle of stationary action is re-expressed using this formalism. The same relation between Hamiltonian and Lagrangian as before, but a much larger class of allowable variations is found, namely those associated with any $C^\infty$ vector fields. (auth)

**21330** RELATIVISTIC TEMPERATURES. Grosjean, P. V. (Univ., Mons, Belg.). Bull. Soc. Roy. Sci. Liege; 43: No. 3-4, 260-265(1974). (In French).

Consideration of the problem of relativistic temperature measurements, where an observer is considered as a fluid moving at a relativistic velocity with respect to a fluid whose temperature he is trying to measure. A relation between proper and measured temperatures is derived on the supposition that if such an observer wants to measure the temperature of the fluid, he must be in equilibrium with it in Schmid's (1970) sense. The formula does not presuppose orthogonality, as have previous ones, but rather is connected with an affine group acting on certain privileged, non-orthogonal frames. (IAA)

**21331** MASSLESS QUANTUM ELECTRODYNAMICS IN SIX-SPACE. Ng, J. N. H. Seattle; Univ. of Washington (1974). 121p. University Microfilms Order No. 75-4025.

Thesis (Ph. D.).

High energy behavior of quantum electrodynamics is studied in a new light cast by the conformal invariant property of the massless theory. The linear realization of conformal symmetry in a six-dimensional space is employed to formulate a complete set of Feynman rules which enables calculation in this six-dimensional space. The amplitude, H, for the one-rung ladder diagram is calculated and the first radiative correction to the vertex function is obtained from H by taking the limit where two coordinates approach each other. The Ward's identity then gives the first radiative correction of the electron propagator. The one-electron loop function $f_1(\alpha)$ for the photon vacuum polarization is calculated to order $\alpha^2$ and the Jost-Luttinger result is recovered. (Diss. Abstr. Int., B)

**21332** COMPOSITE FIELD THEORY AND THE STRATON MODEL. I. Ho, T. H.; Huang. T. (Inst. of Atomic Energy, Moscow). Wu Li Hsueh Pao; 23: No. 4, 264-291(Jul 1974). (In Chinese).

The composite field theory is generalized to the case when basic field is spinor, and the relevant formula is derived in the straton model for the processes involving mesons. It is shown that the results obtained are valid for other models also. (auth)

**21333** PRECISE VALUES FOR CRITICAL FIELDS IN QUANTUM ELECTRODYNAMICS. Soff, G.; Mueller, B. (Frankfurt Univ. (F. R. Germany). Inst. fuer Theoretische Physik); Rafelski, J. (Pennsylvania Univ., Philadelphia (USA). Dept. of Physics). Z. Naturforsch., A; 29: No. 9, 1267-1275(Sep 1974).

A careful investigation of different corrections to binding energies of electrons in almost critical fields is performed. We investigate quantitatively the influence of the nuclear charge parameters, nuclear mass, degree of ionization on the value of the critical charge of the nucleus. Rather qualitative arguments are given to establish the contribution of the quantum-electrodynamic corrections, which are found to be small. Some phenomenological modifications of QED are quantitatively investigated and found to be of negligible influence on the critical field. For heavy-ion collisions with $Z_1 + Z_2 > Z_{cr}$ the critical separations between ions are given as results of precise solutions of the relativistic two-Coulomb-center problem. Corrections due to electron–electron interaction are considered. We find (with present theoretical accuracy) $Z_{cr} = 173 \pm 2$, in the heavy-ion collisions $R_{cr}(U-U) = 34.7 \pm 2$ fm and $R_{cr}(U-Cf) = 47.7 \pm 2$ fm. We briefly consider the possibility of spontaneous muon production in muonic supercritical fields. (auth)

# Gravitation and General Relativity

**21334** (AD-770160) USE OF SYMBOLIC MANIPULATION TECHNIQUES TO EXAMINE GRAVITATIONAL AND UNIFIED FIELD THEORIES. Technical Report No. 1, 30 June–30 November 1973. Yilmaz, H.; Pavelle, R. (Perception Technology Corp., Winchester, Mass. (USA)). 30 Nov 1973. Contract DAHC15-73-C-0369. 46p. NTIS $3.00.

This is the six month technical report for the contract. Following the report summary are seven appendices. The first is a published description of the new theory of gravitation and its ramification while the subsequent six are concerned with research performed during the first five months of the present contract. (GRA)

**21335** (JINR-E2-8323) NOTE ON LOCAL PROPERTIES OF THE GREEN FUNCTIONS OF SCALAR FIELD IN GENERAL RELATIVITY. Il'yn, S. B.; Tagirov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 9p. Dep. NTIS (US Sales Only) $4.00.

It is noticed that the Green function $\bar{G}(x,x')$ of the conformal covariant (for $m = 0$) general relativistic scalar wave equation $(\Box + R/6 + m^2)\,\phi = 0$ coincides for $x' \to x$ with the corresponding Green function in the Minkowsky space time, whereas $\bar{G}(x,x')$ of the traditional equation $(\Box + m^2)\,\phi = 0$ does not possess such a property. (auth)

**21336** POYNTING'S THEOREM FOR THE EINSTEIN SYSTEM. Kulhanek, J. D. (Laboratorni Pristoje, Prague). Lett. Nuovo Cim.; 11: No. 16, 691-696(21 Dec 1974).

A formal analogy with the Maxwell electrodynamics is followed in the treatment of a set of criteria established for the choice of

an energy–momentum complex of the metric field. This is shown for equations of the Einstein system. (JFP)

**21337** GRAVITATIONAL CONSTANT. Krat, V. A.; Gerlovin, I. L. (Astronomical Observatory, Leningrad). Dokl. Akad. Nauk SSSR; 215: No. 2, 305-306(11 Mar 1974). (In Russian).

The value of the gravitational constant from experimental data and from calculations made on the basis of the fundamental field theory and the evaluation of dimensionless constants are compared. It is concluded that the theoretical value of G can be considered as a prediction while calculating it from new experimental data. A very clear relation is established between the gravitational constant and other universal constants. (JSR)

**21338** ONE METHOD OF SOLUTION OF THE SYSTEM OF EINSTEIN EQUATIONS. Kucherenko, E. I.; Loskutov, A. V. (Ryazan Radiotechnical Inst., USSR). Dokl. Akad. Nauk SSSR; 215: No. 5, 1071-1073(11 Apr 1974). (In Russian).

An approximate method (a combination of the direct and Galerkin methods) was proposed for the search for the solution of the Einstein field equations in the Cobolev space $W_2$ (Q), complete in the class of generalized functions. (JSR)

# REACTOR TECHNOLOGY AND REGULATION

**21339** (74-CNA-500, pp 19) NUCLEAR ENERGY AND THE CONSULTANT. Taylor, A. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-500.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 5. Impact of nuclear energy on industry.

Canadian "consultants" (i.e., engineering firms working under contract) have played a major role in the nuclear industry at home and abroad. They were involved in the construction or running of the Trombay Research Reactor and Rajasthan Power Project in India and of the KANUPP station in Pakistan. Hydro-Quebec will use consultants working directly for them (not for AECL) to design the non-nuclear side of Gentilly-2. Two major engineering firms constructing heavy-water plants in Canada may before long be asked to advise on building them abroad. Apart from such major tasks, there are many small research contracts placed by AECL with engineering firms. (INIS)

**21340** THE VERBOIS NUCLEAR POWER STATION. Wuetherich, R. (S. A. l'Energie de L'Ouest-Suisse, Lausanne, Switzerland). Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1066-1068 (13 Jul 1974). (In French).

Discussions have been taking place since 1968 between EOS and the Geneva authorities about the possibility of building a nuclear power station. After many studies and much preliminary work, the Swiss Federal Department of Transport, Communication and Energy approved the siting of a nuclear power station at Verbois. At present it is planned to erect on this site a nuclear power station rated at between 800 and 1100 MW and cooled by water from the Rhone. The advantages of the site are briefly discussed. The type of reactor has not yet been chosen. (auth)

**21341** THE RUETHI NUCLEAR POWER STATION. Veya, R. (Nordostschweizerische Kraftwerke A. G., Baden). Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1069-1072(13 Jul 1974). (In German).

The Forces Motrices du Nord-Est de la Suisse Co. of Baden (NOK) had planned the construction of a conventional thermal power station at Rüthi, Switzerland. However there was violent opposition to the burning of large quantities of oil and the consequent emission of $SO_2$. The site at Rüthi has advantages because high-capacity, high-voltage transmission lines cross at this point and it is close to pumped-storage power stations planned or under construction. It is now planned to construct a nuclear power station rated at least 900 MW and due to be operational in the early eighties. (INIS)

**21342** THE INWIL NUCLEAR POWER STATION. Gugler, A. (Centralschweizerischen Kraftwerke, Luzern, Switzerland). Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1073-1074(13 Jul 1974). (In German).

The Forces Motrices de la Suisse centrale Co. of Lucerne (CKW) plans the construction of a nuclear power station at Inwil in the region of the Schwissmat, in Switzerland. Work is under progress to permit the construction as soon as possible of a nuclear power station rated at approximately 1000 MW to help meet the rising demand for electricity in Switzerland. (INIS)

**21343** THE CHOICE OF SITES FOR FUTURE NUCLEAR POWER STATIONS WITH A VIEW TO REDUCING AS MUCH AS POSSIBLE THE DISTANCE OVER WHICH ELECTRICAL POWER HAS TO BE TRANSMITTED. Excerpt from the Report Dated 29 September 1972 of the Federal Commission on Electricity Installations. Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1018-1022(13 Jul 1974). (In French).

The terms of reference, assumptions, and simplifications made in the study and the factors not taken into account are stated. The implications of increases in the demand for electricity in Switzerland by factors of 2 and 4 are analyzed. The report concludes that, with a doubling of the demand for electricity, in addition to the three existing nuclear power stations and the three nuclear power stations under construction at Gosgen, Kaiserangst and Leibstadt, a further two nuclear power stations each of 1000 MW will be required. (INIS)

## Power Reactors, Non-Breeding, BWR-Type

*Refer also to abstracts 21407, 21789, 21790, 21792, 21795, 21811, 21852, 21853, 21871, and 21875.*

**21344** (AI-75-2(Rev.1)) THERMAL HYDROGEN RECOMBINER SYSTEM FOR WATER-COOLED REACTORS. Henrie, J. O.; Stone, L. R. (Atomics International Div., Canoga Park, Calif. (USA)). 10 Feb 1975. 52p. Atomics International Div., Canoga Park, CA.

The AI thermal recombiner system, its major components, and the results of operational acceptance tests conducted with hydrogen in concentrations of 0, 1, 2, 3 and 4% are described. Also described are the analyses and tests performed to demonstrate the capabilities of the system to withstand seismic loading. Additional recombiner performance data obtained from the Development Test System are also reported. These data show satisfactory operation of the system under many conditions simulating postulated containment atmospheres and a wide range of recombiner performance variables. This system is adaptable to satisfy the safety criteria of LOCA gas control systems for either pressurized or boiling water reactor systems. (auth)

**21345** (APED-5750-2) DESIGN AND PERFORMANCE OF GENERAL ELECTRIC BOILING WATER REACTOR MAIN STEAM LINE ISOLATION VALVES. Supplement 2. Nieh, C. T. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). 18 Dec 1974. 4p.

Supplementary information is provided in response to AEC Regulatory Staff requests. Included are discussions on control systems, testing procedures, specifications, and failures. (DG)

**21346** (STH-4/74) TRITIUM MEASUREMENTS IN THE EXHAUST AIR AT STACKS OF NUCLEAR POWER PLANTS WITH LIGHT-WATER COOLED REACTOR P. 1. Measured Data of the Grundremmingen and Obrigheim Nuclear Power Plants. Riedel, H.; Kistner, G. (Bundesgesundheitsamt, Berlin (F. R. Germany). Abt. fuer Strahlenhygiene; Bundesgesundheitsamt, Neuherberg/Muenchen (F. R. Germany). Abt. fuer Strahlenhygiene). Jul 1974. 22p. (In German). INIS.

Tritium has been released continuously in the form of tritiated water and has been measured with a liquid scintillation detector. This measuring technique allows detection of the substance up to a limit of less than 10 $pCi/m^3$. The results measured for the Gundremmingen nuclear power plant show an average tritium concentration in the stack exhaust air of $3.6 \times 10^{-9}$ $Ci/m^3$, leading to an annual release of about 80 Ci. The corresponding data measured for the Obrigheim plant are $8.3 \times 10^{-9}$ $Ci/m^3$ on the average, and 8 Ci/annum. (GE)

**21347** (WASH-1362) NUCLEAR POWER PLANT OPERATING EXPERIENCE DURING 1973. (USAEC Directorate of Regulatory Operations, Washington, D. C.). Dec 1974. 142p. (OOE-ES-004). Dep. NTIS $10.25.

The operating experience of 30 U. S. nuclear power plants in commercial operation during 1973 was reviewed by the Atomic Energy Commission Regulatory Staff. Power generation statistics, plant outages, fuel element performance, surveillance test results, radiation exposures, radioactive effluent releases, abnormal occurrences and unusual events were included in the review. Summary highlights of these areas are presented. These power plants contributed about 4% of the total electrical energy generated in the United States during 1973. The average nuclear power plant availability factor was 71%, and the average plant capacity factor was 56%. No adverse effect on the public health and safety resulted from nuclear power plant operations. (auth)

**21348** ACCESS TO THE PRESSURE VESSEL OF A DIRECT CYCLE BWR FOR INSPECTION AND MAINTENANCE. Hock, R.; Seifferth, L. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Frankfurt am Main). pp 860-880 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

In power plants currently under construction, inspection of the important parts of the pressure vessel has to be included in the design. In order to avoid expensive and less reliable inspection devices with remote control, direct access is desirable. Measurement of dose rates after shutdown have been performed under different conditions: vessel drained or filled with water, reactor core in place or unloaded. It was shown, that rather simple calculations are in good agreement with these measurements. The same calculational methods have been used to predict the dose rates after shutdown in new plants. (FR)

**21349** CONTROL OF SHIELD CALCULATION BY TEST MEASUREMENTS IN THE BIOLOGICAL CONCRETE SHIELD OF THREE GERMAN POWER REACTORS. Futtermenger, W. (Technische Univ., Hanover); Schultz, H.; Vogt, H. G.; Hecht, G.;

Weber, H.; Hock, R. pp 1026-1046 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

Neutron and photon measurements in the biological shields of three German power reactors are compared with design calculations which were performed with removal-diffusion and transport codes. Satisfactory agreement is obtained between the calculated and measured dose rates. The main contribution to the dose rate at great depth is made by high-energy photons from the iron zones in front of the concrete shield. Therefore high accuracy is required for calculating the neutron and the photon sources in these zones, but not so much for the calculation of the neutrons in the shield. (FR)

**21350** STREAMING OF NEUTRONS AND GAMMA-RAYS ALONG REACTOR COOLANT PIPES. Amin, E.; Hehn, G.; Zumach, W. (Univ., Stuttgart). pp 717-730 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

A systematic investigation has been conducted to determine the streaming effect of neutrons and gamma rays along straight reactor coolant pipes. Different dimensions, as well as a variety of coolant materials have been considered, like water, steam and sodium. The standard material configuration consists of four material zones representing the coolant, the pipes wall, the thermal insulation embedded in the bulk shield. It was found that a large contribution of the total streaming effect is due to the thermal insulation zone which could be reduced by using additional absorber. (FR)

**21351** CHOICE OF CHARACTERISTIC ELEMENT COMPONENTS IN CONCRETE FOR SHIELDING CALCULATIONS ON BIOLOGICAL SHIELDS FOR POWER REACTORS. Schultz, H.; Vogt, H. G. (Technische Univ., Hanover). pp 702-716 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The results of attenuation calculations for biological reactor shields are often hard to compare because of different elemental compositions for the concretes. In order to estimate the influence of the concrete composition, calculations were made for the biological shield of a water cooled power reactor with extreme variations of the concrete aggregates. It turned out that for all investigated concretes (normal concrete and heavy concretes) mean compositions can be recommended without too large errors to be expected. Furthermore characteristic values for the water and iron contents are proposed because of their strong influence on the attenuation. (FR)

**21352** INCIDENTS IN AMERICAN NUCLEAR POWER PLANTS WITH BOILING WATER REACTORS. IRS Kurz-Inform., Reihe A; No. 89, 1-2(1974). (In German).

On three BWRs, cracks were found on 4-inch by-pass pipes of the primary cooling system which have meanwhile been repaired. No radioactivity was released to the surroundings. The USAEC indicated to the electricity supply utility that all 4-inch by-pass pipes of BWRs in operation are to be checked by 17-11-74. There are no orders to immediately shut down all BWRs. (GE)

**21353** OPERATIONAL BEHAVIOR OF LIGHT WATER REACTOR CORES. Knoedler, D.; Maerkl, H. (Kraftwerk Union A. G., Erlangen (F. R. Germany)). Atomwirt., Atomtech.; 19: No. 8/9, 439-443(Aug 1974). (In German).

6 figs.; 1 tab.; 3 refs.

The operational behavior of the fuel elements in reactor cores which are supplied by KWU or CE is examined. Design and experimental conditions of published ramp tests with rod failure did not correspond to the expected KWU fuel rod or reactor conditions. A generally valid quantitative connection between type and number of fuel rod defects, mode of operation of the reactor and the amount and composition of the fission product activity in cooling water cannot be derived from the behavior of various PWR and BWR cores. (GE)

**21354** ENGINEERING APPROACH TO SHIELD DESIGN. Van Halem, H.; Kuiken, R. (Comprimo N. V., Amsterdam). pp 136-148 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From fourth international conference on reactor shielding; Paris, France (9 Oct 1976).

In order to obtain an optimized shield design that satisfies the safety limits and operates at minimum cost an estimate should be made of the basic errors in the parameters governing shield design. This evaluation applies specifically to bulk shielding of boiling water reactors, but the results are thought to be conclusive for pressurized water reactors as well. Major errors are due to neutron cross sections, to gamma yields and to the effect of drying out of the concrete. The total error margin evaluated corresponds to approximately 15 cm in concrete thickness. Further reduction of the error margin requiring more extensive calculations is economically unattractive. (FR)

**21355** THE SPECIAL CHARACTERISTICS OF DRIVES IN NUCLEAR POWER STATIONS. Rohmer, K. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Berlin (F. R. Germany). Fachgebiet Grossmaschinen). At. Strom; 20: No. 7/8, 81-85(Jul 1974). (In German).

5 figs.; 2 tabs.; 18 refs.

On the basis of the fundamental principles of boiling-water and pressurized water reactors the functions and the conditions of use of the main coolant pumps and their drive motors are described. The conditions of use determine the requirements for the drive motors. Their effect on the electrical and mechanical arrangement of drive motors for the main coolant pumps in boiling-water and pressurized water reactors is described. (GE)

**21356** NUCLEAR INFORMATION CENTERS. Gold, V. R. (ed.). New York; Atomic Industrial Forum, Inc. (Jan 1975). 51p. $20.00.

Specifications are presented for public information centers that are associated with nuclear power plants. The types of buildings and locations with regard to the nuclear power plants, the types of exhibits and programs offered, operating schedules, staff requirements, physical aspects, and architecture characteristics are listed. (DCC)

**21357** BWR/6 EMERGENCY CORE COOLING SYSTEM. Hench, J. E. (General Electric Co., San Jose, Calif. (USA)). Neue Tech.; 16: No. 7, 264-266(Jul 1974).

The ECCS consists of a high pressure core spray system (HPCS), a low pressure core spray system (LPCS), a low pressure coolant injection system (LPCI), and an automatic, depressurization system (ADS). The different subsystems of the ECCS are described in detail. (auth)

**21358** ACTION AGAINST PRELIMINARY DECISION ON THE SITE OF NUCLEAR POWER PLANT KRUEMMEL HAS BEEN DISMISSED. Energiewirt. Tagesfragen; 24: No. 8/9, 444-447 (Sep 1974). (In German).

After the request to stay the "immediate execution" of the preliminary decision on the site of the nuclear power plant Kruemmel has been rejected by two courts, the action for reversal of the preliminary decision on the site of the reactor in question has now likewise been dismissed by the administrative court of Schleswig. Some reasons of the decision are briefly outlined. (GE)

**21359** CONSIDERATIONS AFFECTING THE DESIGN OF THE STEAM TURBINE FOR THE KAISERAUGST NUCLEAR POWER STATION. Muehlhaeuser, H. (Brown, Boveri and Co. Ltd., Baden (Switzerland)). Neue Tech.; 16: No. 7, 267-269(Jul 1974). (In German).

A single-shaft 3000 rev/min design with a single-cylinder, high-pressure turbine and a three-cylinder, low-pressure turbine was chosen for the steam turbine for the Kaiseraugst nuclear power station in Switzerland. The technical considerations which led to this solution are briefly discussed. A comparison is made between the 3000 - rev/min and the 1500 - rev/min turbine from the point of view of weights and dimension, thermal efficiency and itemized losses, power-station layout, blade erosion, transport, erection and maintenance. (INIS)

**21360** THE KAISERAUGST NUCLEAR POWER STATION IS UNDER CONSTRUCTION. Tappy, E. (Motor-Columbus A. G., Baden (Switzerland)). Neue Tech.; 16: No. 7, 243-246(Jul 1974). (In German).

A brief historical account is given of some of the preliminary technical studies and legal work undertaken by Motor-Columbus and the other members of the Kaiseraugst nuclear power station study consortium. The Kernkraftwerk Kaiseraugst Co. was formed in January 1974 and details are given of the Swiss, French and German financial participation. The contractors and main design changes are detailed, and the part played by the station in relation to other Swiss nuclear power stations and the Swiss power system as a whole are briefly discussed. (INIS)

**21361** BWR/6-REACTOR DESIGN. Jacobson, J. (General Electric Co., San Jose, Calif. (USA)). Neue Tech.; 16: No. 7, 255-258(Jul 1974).

In the Kaiseraugst type boiling water reactor the reactor assembly contains the equipment and instrumentation necessary to produce and contain the steam power required by the plant. The major equipment categories and components in the reactor assembly are as follows: (a) Fuel--Including fuel assemblies and chan-

nels. (b) Instrumentation–Including neutron sources, in-core monitors, in-core guide tubes and in-core housings. (c) Control–Including control rods, control rod drives, control rod guide tubes. (d) Steam Generating–Including feedwater spargers, jet pumps, steam separators, dryers and associated pressure vessel nozzles. (e) Structural–Including reactor pressure vessel, shroud, shroud head, shroud head bolts, core plant and top guide. (f) Core cooling Protection Systems–Including core spray lines, core spray sparger, low pressure coolant injection (LPCI) connections and various other pressure vessel nozzles for safety system connections. (auth)

**21362** THE KAISERAUGST NUCLEAR POWER STATION: BRIEF TECHNICAL DESCRIPTION. Graf, P.; Klaentschi, M.; Mamuzic, M.; Haenni, H.; Zuend, H. (Motor-Columbus Ingenieurunternehmung A. G., Baden (Switzerland)). Neue Tech.; 16: No. 7, 247-255(Jul 1974). (In German).

After summarizing the events leading to the placing of the order for the Kaiseraugst nuclear power station in Switzerland with the BBC/GETSCO/SOGER-CA/CEM consortium, the considerations behind the siting and the design of the station and a brief technical description of the installation are presented. The items included are the reactor, the emergency cooling system, the cooling system and cooling towers. The safety aspects are also discussed. The main operating parameters are presented in tabular form. (INIS)

**21363** KAISERAUGST NUCLEAR POWER STATION. Graf, P. (Kernkraftwerk Kaiseraugst AG, Baden, Switzerland). Neue Tech.; 16: No. 7, 241-242(Jul 1974). (In German).

An introductory note to a series of articles dealing with specific aspects of the Kaiseraugst nuclear power station under construction in Switzerland is presented. Reference is made to the opposition encountered and the consequent delays caused to the power station which is now expected to be operational for the 1978/79 winter after a five-year construction time and to the contribution which the 920-MW power station will make to electrical power generation in Switzerland. The technical, commercial and political advantages arising from the Swiss/French/German partnership are discussed. (INIS)

**21364** THE LEIBSTADT NUCLEAR POWER STATION. Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1049-1052(13 Jul 1974). (In German).

Brief technical details are given of the Leibstadt nuclear power station under construction in Switzerland. The station is designed for an electrical rating of 940 MW and will use a boiling-water reactor. The turn-key contract for the station was placed with the Brown Boveri/General Electric of America (BBC/GETSCO) consortium in February 1973. General Electric is responsible for the nuclear steam generator and Brown Boveri for the turbine and generator. The programme envisages that the station will become operational at the beginning of the 1978/9 winter. (INIS)

**21365** PRIMARY CIRCULATION PUMPS FOR WATER REACTORS. Com. Naz. Energ. Nucl., Notiz.; 20: No. 11, 68-73(Nov 1974). (In Italian).

The final text of UNICEN Draft Standard no. 11, as approved by UNI's Nuclear Energy Committee in April 1974 is presented. (auth)

**21366** NUCLEAR POWER PLANTS IN OPERATION AND UNDER CONSTRUCTION IN THE SOVIET UNION (30 JUN 1974). Lavrencic, D. Com. Naz. Energ. Nucl., Notiz.; 20: No. 11, 61-64(Nov 1974). (In Italian).

## Power Reactors, Non-Breeding, PWR-Type

*Refer also to abstracts 21344, 21346, 21347, 21349–21351, 21353–21356, 21365, 21366, 21407, 21768–21771, 21786, 21790–21792, 21795, 21811, 21863, 21869, 21870, and 21875.*

**21367** (AED-CONF-74-435-002) ENSURING PROCESS STEAM SUPPLY BY MEANS OF VARIABLE PRESSURE TANKS IN CASE OF A FAILURE IN THE BASF NUCLEAR POWER PLANT. Moench, R. (BASF (Badische Anilin- und Soda-Fabrik A. G.), Ludwigshafen am Rhein (F.R. Germany)). 1974. 10p. (In German). (CONF-741061-2). INIS.

From meeting on storage systems for secondary energy; Stuttgart, F. R. Germany (2 Oct 1974).

A typical application of vapour storage as instantaneous reserve to bridge the starting or running-up times of reserve plants in the case of a failure of the planned BASF nuclear power plant is presented. The discussion of the actual problems of the standby covering is dealt with following a review of the situation of the projected nuclear power plant. (GE)

**21368** (CENPD-172) PLANT PROTECTION SYSTEM WITH INTEGRATED AUTOMATIC TEST SYSTEM. Brooks, J. G.; Moreau, R. J. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jan 1975. 223p.

Combustion Engineering's recently developed Plant Protection System with Integrated Automatic Test System is described. Since the system is an option of C-E's System 80 design, the report is in the form of change pages to the C-E Standard Safety Analysis Report (CESSAR). As an aid to understanding of the total system and to provide continuity of thought, unaffected CESSAR pages have also been included where appropriate. (auth)

**21369** (CONF-7210130-, pp 217-221) DESIGN AND OPERATION OF NUCLEAR REACTOR PRESSURE VESSELS. Mager, T. R.; Enrietto, J. F. (Westinghouse Electric Corp., Pittsburgh). 1972.

From colloquium on structural reliability: the impact of advanced materials on engineering design; Wright Patterson AFB, Ohio, USA (9 Oct 1972).

In proceedings of the colloquium on structural reliability: the impact of advanced materials on engineering design.

Because of the quality of the melting practice, fabrication preservice and in-service inspection procedures in addition to the stress limits allowed by Section III of the ASME Boiler and Pressure Vessel Code nuclear reactor components, are safe to operate under normal, upset and test conditions. In addition, analyses have shown that nuclear power plants can be shutdown in a safe manner and maintain the integrity of the system during faulted or postulated accidents and emergency conditions. Inspection programs for PWR pressure vessels are described. (auth)

**21370** (CONF-730372-1) SOME DESIGN ASPECTS OF FLOATING NUCLEAR PLANTS. Dotson, C. (General Dynamics Corp., Quincy, Mass. (USA)). Mar 1973. 22p. General Dynamics, Quincy, MA $2.00.

From conference presented to New England section of the Society of Naval Architects and Marine Engineers; Quincy, Massachusetts, USA (16 Mar 1973).

By 1985, Offshore Power Systems' manufacturing concept and offshore siting will be significant in reducing some of the concerns which are believed to contribute in leading to delays in the growth of the nation's nuclear generating capacity. In the heavily populated seaboard areas, the Floating Nuclear Plant provides a way to meet man's increasing power requirements with a minimum effect on his environment. Some design aspects of the Floating Nuclear Plant and the manufacturing facility for the plants are described. (auth)

**21371** (CONF-741065-6) ESTIMATION OF VIBRATION OF REACTOR INTERNALS BY NOISE ANALYSIS OF NON-NUCLEAR PARAMETERS. Bastl, W.; Bauernfeind, V. (Technische Univ. Muenchen, Garching (F.R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). 1974. 27p. Dep. NTIS (US Sales Only) $4.50.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

The application of noise analysis techniques to the monitoring of mechanical vibrations of PWR internals is discussed. Measurements were made at the Biblis reactor and the Stade reactor using displacement and pressure sensors, and mathematical models were used to describe the observed vibrational characteristics. (DG)

**21372** (TID/SNA-100) AEROJET NUCLEAR SYSTEMS COMPANY PROPOSAL NR700059 FOR FUEL POOL SERVICES PLATFORM, NEW FUEL ELEVATORS, AND SPENT FUEL STORAGE RACKS. Bush, D. E. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 25 Mar 1970. 31p. Dep. NTIS $4.75.

**21373** (WCAP-8454) ANALYSIS OF DATA FROM THE ZION (UNIT 1) THINC VERIFICATION TEST. Burke, T. M.; Meyer, C. E.; Shefcheck, J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Dec 1974. 125p.

A test was performed on the Zion Unit 1 reactor for the purpose of obtaining data to be used in providing additional verification of the adequacy of current Westinghouse nuclear and thermal hydraulic design methods. This test was designed to obtain coolant conditions highly disturbed from those occurring during normal operation and, in fact, approach conditions at the reactor operating limits at which the reactor would trip by the Overtemperature $\Delta T$ protection system. A comparison of measured fuel assembly exit temperatures to those predicted by the THINC code verifies the adequacy of the analysis even as reactor operating limits are approached. The exit temperature is conserva-

tively overpredicted in the high power assemblies with relative powers greater than 1.2. In addition, the adequacy of Westinghouse nuclear design procedures is further verified by good agreement between predicted and measured core power distributions under abnormal conditions. The agreement between measured and predicted values is within 5% on assembly relative power and within 2% on peak rod relative power. Finally, the adequacy of the overall combined Westinghouse nuclear/thermal hydraulic analysis of the core is demonstrated by comparison of measured fuel assembly exit temperatures to those predicted by the THINC code using predicted power distributions. 5 references. (auth)

**21374** THE BIBLIS NUCLEAR POWER STATION. Marggraf, G. (Rheinisch-Westfaelisches Elektrizitaetswerk A. G., Essen (F. R. Germany). Projektgruppe Biblis). At. Strom; 20: No. 7/8, 69-80(Jul 1974). (In German).

8 figs.; 1 tab.

With the first criticality of the reactor on the 16th of July 1974 and the start-up of the turbine on the 13th of August 1974, two important conditions were fulfilled for the commissioning of the Biblis nuclear power station-Block A. A review is presented of the construction of the nuclear power station and the progress made so far. (auth)

**21375** PRACTICAL ANALYSIS OF PRIMARY CONCRETE SHIELD FOR A PWR. Su, S. D.; Patti, F. (Burns and Roe, Inc., Oradell, NJ). pp 628-646 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The radiation shielding properties of ordinary concrete are studied at a density of 2.35g/cc for the primary shield of a selected large pressurized water reactor(PWR) system. The associated heating resulting from radiation incident on the concrete shield is analyzed. The neutron and gamma flux distributions in the shield are obtained with the removal-diffusion NRN code and point-kernel QAD-BR code, respectively. Calculations of the relaxation lengths of fast neutrons and gammas in ordinary concrete are made. The results presented are compared with some reported data. (FR)

**21376** ACTIVITY OF THE CORROSION PRODUCTS IN THE PRIMARY WATER OF CHOOZ REACTOR. Frejaville, G. (CEN de Fontenay-aux-Roses, France); Lott, M.; Marchal, A. pp 898-913 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The concentration and activity measurements of corrosion products in the primary coolant of Chooz reactor during steady run and after shutdown permit the release rate of the metallic structures (0.8 mg · $dm^{-2}$ · $month^{-1}$), the half life deposition time in core ($T_{(1/2)}$ = 10 mn) and out of core ($T_{(1/2)}$ = 2h). These measurements show the very important increase of activity in the coolant (approximately 1000) after a shutdown when the temperature is decreased till 100°C. (FR)

**21377** CONTINUOUS ESTIMATION OF THE DAMAGE RATE FOR PWR VESSELS. Devillers, C.; Dupont, C. (CEN de Saclay, Gif-sur-Yvette, France). pp 914-922 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

Within the scope of the surveillance programs of reactor pressure vessels, the methods used to evaluate the progression of irradiation embrittlement along the life of the reactor are given. An idea of measurement which should provide a direct estimation of the fast neutron fluence and of the damage dose is presented. (FR)

**21378** A NEW ON-LINE METHOD FOR DETERMINING THE BURNUP DISTRIBUTION IN PRESSURIZED WATER REACTORS. Fleck, C. M. (Atominstitut der Oesterreichischen Hochschulen, Vienna); Bauer, H.; Moldaschl, H. (Kraftwerk Union A. G., Erlangen (F.R. Germany)). Kerntechnik; 16: No. 10, 445-448 (Oct 1974). (In English, German).

A new method for measuring the local burnup was tested at the Obrigheim nuclear power station with the aid of the existing activated bead measuring system. The gross spectrum $\phi_s/\phi_{th}$ was obtained by altering the temporal sequence routine of bead stack measurements. The local burnup was then determined by comparing this spectrum with a burnup-dependent computed gross spectrum. The advantages of the new method are based on its simplicity and relatively high accuracy. The method requires no consecutive cyclic measurements of the neutron flux density distribution. Instead, the entire burnup information is obtained from a single measurement provided the absorber distribution (boron, control rods) in the core during this measurement is known and provided a calibration measurement has been carried out a sufficiently long time previously. (auth)

**21379** THE GOESGEN NUCLEAR POWER STATION. Vogt, H. W. (Kernkraftwerk Goesgen-Daeniken A. G., Daeniken (Switzerland)). Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1024-1043(13 Jul 1974). (In German).

Following the placing in service of the Beznau II and Mühleberg nuclear power stations in 1971 and 1972, the decision to build the Gösgen nuclear power station was taken in 1973 and it is hoped that it will be operational in the autumn of 1977. The Station will have a net electrical rating of 920 MW and will use a pressurized water reactor. The turn-key contract was placed with Krafwerk Union. In addition to technical details, brief information is given on the preliminary studies, the types of reactor which were considered and some of the Federal and Cantonal legal aspects. (INIS)

**21380** THE BUGEY NUCLEAR POWER STATION (RHONE, FRANCE). Participation of Swiss Electrical Power Companies. Vaterlaus, J. (ETH/HTL, Luzern, Switzerland). Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1053-1055(13 Jul 1974). (In German).

Brief technical details are given of the 2nd and 3rd units of the Bugey nuclear power station under construction in France near Lyon for EdF. These units are each rated at 925 MW net and will use a Westinghouse pressurized water reactor. The second unit is expected to be operational at the beginning of 1977 and the third at the end of 1977. Switzerland has a 17.5% financial interest in the 2nd and 3rd Bugey units through Aktiengesellschaft fur Kernenergie-Beteilungen Luzern (AKEB) and will consequently be entitled to approximately 17.5% of the electrical energy output. (INIS)

**21381** THE FESSENHEIM NUCLEAR POWER STATION (UPPER RHINE, FRANCE). Participation of Swiss Undertakings. Bull. Schweiz. Elektrotech. Ver.; 65: No. 14, 1056-1060(13 Jul 1974). (In French).

Features of technical and general interest are given of the Fessenheim nuclear power station under construction in France for EdF. Each of the two stages of the station will contain a unit having a net electrical rating of 900 MW with a pressurized water reactor. The first stage is expected to be operational at the beginning of 1977 and the second at the end of 1977. Switzerland has a 15% financial interest in the power station through the Centrales Nucleares en Participation Co (CNP) and will be entitled to approximately 15% of the electrical energy output. (INIS)

**21382** THE INSTALLATION OF NEUTRAL-POINT SWITCHES ON THE 220kV SIDE OF THE GENERATOR TRANSFORMERS AT THE BEZNAU-DOETTINGEN NUCLEAR POWER STATIONS. Hartmann, H. (Nordostschweizerische Kraftwerke A. G., Baden). Bull. Schweiz. Elektrotech. Ver.; 65: No. 18, 1335-1340(7 Sep 1974). (In German).

The construction of large nuclear power stations, connected to 220 kV and 380 kV systems, give rise to an undesirable increase in short-circuit currents and, in the case of direct neutral-point earthing of the generator transformers, increased earth-fault currents. A limitation of these currents can be obtained by not earthing all of the transformer neutral points. With this arrangement, however, it is necessary to take account of certain switching operations which put the installation at risk in the case of the transformers the neutral points of which are effectively isolated. These dangers can be avoided by installing a switch at the neutral point, satisfying certain conditions, as has been provided in the case of the four 220 MVA generator transformers at the two nuclear power stations Beznau I and Beznau II. (INIS)

**21383** AN ORIGINAL SYSTEM FOR MEASURING THE CONTROL BAR POSITION IN A PRESSURED WATER REACTOR. Lavergne, R. (Etablissements Merlin et Gerin, 38 - Grenoble (France)). Kerntechnik; 16: No. 10, 442-444(Oct 1974).

In a nuclear reactor the control rods have an essential function. Various principles have been adopted to operate them, but the accurate measurement of their position is a delicate problem. The new original position monitoring system developed by Merlin Gerin for pressured water reactors offers the advantage of directly delivering accurate, reliable and easily usable digital data at the output of the sensor. (auth)

**21384** EXPERIENCE WITH THE NUCLEAR INSTRUMENTATION OF THE NUCLEAR POWER PLANT STADE. Klar, E.; Schaffer, S.; Spillekothen, H. G. (Kraftwerk Union A. G., Erlangen (F.R. Germany)). Atomwirt., Atomtech.; 19: No. 10, 477-480(Oct 1974). (In German).

The operational application of fixed incore detectors under power reactor conditions is described. Experience with the behavior of miniature fission chambers and neutron-beta-detectors is presented on a large scale. The results have been obtained

during the period of start-up to the first refueling operations. Also, the difficulties arising in connection with the prototype instrumentation are thoroughly described. (auth)

## Power Reactors, Non-Breeding, Graphite Moderated

*Refer also to abstracts 21366, 21778, 21782, and 21863.*

**21385** (AEEW-M-1259) COMPARISON OF AN ANALYTICAL AND A DIFFERENCE APPROXIMATION SOLUTION TO THE NUCLIDE DEPLETION EQUATIONS. Harris, D. W. G. (UKAEA Reactor Group, Winfrith, Atomic Energy Establishment). Aug 1974. 12p. Dep. NTIS (US Sales Only) $4.00.

This note compares an analytical solution of the depletion equations for a few chosen nuclides with a solution based on a difference approximation due to Sidell. It is shown that for the particular choice of nuclides the analytical solution has a distinct advantage especially when the cost of whole reactor depletion calculations is considered. The particular application envisaged involves relatively few nuclides and this conclusion would not necessarily apply for the general depletion equations involving many fission products. (auth)

**21386** (DEU-74-4) INVESTIGATION INTO THE FEASIBILITY OF A PRESTRESSED CAST IRON REACTOR PRESSURE VESSEL. Reactor Pressure Vessel Made of Cast Iron (I). Eisenblaetter, J.; Hess, E.; Kaltenhaeuser, A.; Kober, K. J.; Stahl, W.; Winter, H. (Battelle-Institut e.V., Frankfurt am Main (F. R. Germany); Ministerium fuer Wirtschaft, Mittelstand und Verkehr des Landes Nordrhein-Westfalen, Duesseldorf (F. R. Germany)). Sep 1973. 194p. (In German). INIS.

In the present study, the basic suitability of a prestressed cast iron pressure vessel (VGD) according to the conceptions of the firm Siempelkamp for a gas-cooled high temperature reactor with a capacity of 300 MW(e) is investigated with regard to its mechanical, thermal, nuclear technical and economical feasibility. Thereby the prestressed concrete pressure vessel (SBB) of the Schmehausen thorium high-temperature reactor (THTR) has been taken into consideration. (GE)

**21387** (GEAP-14018(Vol.1)) VHTR FOR PROCESS HEAT. Volume 1. (General Electric Co., Fairfield, Conn. (USA). Energy Systems and Technology Div.). Sep 1974. Contract AT(04-3)-189. 392p. Dep. NTIS $10.60.

A technical and economic assessment of a 3000 MW(t) very-high-temperature helium cooled reactor for use as a heat source in industrial processes is presented. System requirements and capabilities, conceptual designs, and cost analyses are discussed. Topical reports are included on process interface requirements, system concepts, fuels design, and reactor parametric relations. (JWR)

**21388** (GEAP-14018(Vol.2)) VHTR FOR PROCESS HEAT. Volume 2. (General Electric Co., Fairfield, Conn. (USA). Energy Systems and Technology Div.). Sep 1974. Contract AT(04-3)-189. 465p. Dep. NTIS $10.60.

Reports prepared for the assessment of a 3000 MW(t) very-high-temperature helium cooled reactor for use as a heat source in industrial processes are presented. These include materials for high temperature service, nuclear island civil structures, reactor development, specification of mechanical equipment, safety evaluation, and plant operating experience and availability. (JWR)

**21389** (JUL-1103-RG-SE) POSSIBILITIES TO IMPROVE AND SECURE THE ENERGY SUPPLY, USING HIGH-TEMPERATURE REACTORS FOR THE GENERATION OF HEAT AND POWER, DEMONSTRATED FOR SPAIN. Narberhaus, H. W. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). Aug 1974. 122p. (In German). Dep. NTIS (US Sales Only) $9.25.

Thesis. Submitted to Technische Hochschule, Aachen, West Germany.

The possibilities of installation and the market potential for high-temperature reactors in the Spanish economy were studied. An analysis is made of the energy industry and the energetic aspects of the iron and steel industry, the chemical industry, and the desalting of seawater. By a comparative cost-analysis of the fossil and nuclear power and heat generation, the effects of the HTR installation are quantified and shown in their energetic, ecologic, and economic importance. (auth)

**21390** (JUL-1109-RB) INVESTIGATIONS OF A FOIL INSULATION IN A HORIZONTAL PRESSURE PIPE. Broeckerhoff, P.; Scholz, F. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorbauelemente). Sep 1974. 131p. (In German). Dep. NTIS (US Sales Only) $9.75.

In a high-pressure gas duct steel foil insulation, especially devised for HHT applications, was investigated in a horizontal pressure pipe under pressures between 1 bar and 40 bars and temperatures up to 400°C. Air and helium were used as testing gases. It was shown that the free convection of gases in the circumferential gaps which were first supposed to be harmless, caused undue asymmetries in the distribution of temperatures and heat fluxes. After elimination or decrease in dimension of these gaps very satisfying results were achieved especially for helium. (auth)

**21391** (JUL-1113-RG) PEBBLE BED HIGH TEMPERATURE REACTOR AS A SOURCE OF NUCLEAR PROCESS HEAT. Volume 1. Conceptual Design. Schulten, R.; Kugeler, K.; Kugeler, M.; Niessen, H.; Hohn, H.; Woike, O.; Germer, J. H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorentwicklung; General Electric Co., Sunnyvale, Calif. (USA)). Aug 1974. 76p. Dep. NTIS (US Sales Only) $7.00.

A conceptual design is proposed for a process heat reactor with ball fuel elements and a gas outlet temperature of 950°C. A short description is given of interesting processes, especially those which utilize a steam reformer. Details are given about the components, in particular the process heat exchangers. A short description of the technical safety problems and the development status is presented. (auth)

**21392** INVESTIGATIONS OF SHIELDING PROBLEMS ARISING FROM MODIFICATIONS TO REFUELLING MACHINERY AT TRAWSFYNYDD POWER STATION. Pugh, I. G. (Central Electricity Generating Board, Cheltenham, Eng.); Hoverd, R. S.; Avery, A. F. pp 973-995 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

An extensive series of calculations and measurements performed for a complex arrangement of shielding which recently required investigation on an operating power station is presented. The original design calculations using one-dimensional removal-diffusion plus line-of-sight methods are described and the resulting dose rates compared with measured values. As the dose rates were considered to be excessive, various methods of reduction are investigated: mock-up experiments using temporary polythene shielding are described; the effect of an increase in decay of the fuel is investigated; and Monte-Carlo calculations are used to identify weak penetration paths in the shield arrangement. (FR)

**21393** CALCULATION OF THE ACTIVITY OF THE CIRCUITS IN A HIGH TEMPERATURE REACTOR. Brisbois, J.; Beslu, P.; L'Homme, A. CEN de Saclay, Gif-sur-Yvette, France). pp 828-859 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

In a HTR reactor, the circuit activity, particularly the heat exchanger activity, comes mainly from the metallic fission products escaped from the fuel. Such a fuel is made from oxide particles coated with PyC and SiC but part of it has a defective coating (due to fabrication hazards or irradiation damages). It is explained how to calculate the fission product activity in the circuits to know the number of failed particles. The calculations can be divided in two steps: migration of the fission products through graphite parts of the fuel, and migration of the fission products in the circuit. For both these problems a model has been developed from the study of the physical phenomena concerned. Example is given of an application to a 3000MW(t) reactor. (FR)

**21394** HEAT GENERATION IN SHIELD LAYERS OF A HIGH-TEMPERATURE REACTOR. Hofmann, K.; Wahsweiler, H. G.; Weicht, U. (Hochtemperatur-Reaktorbau, GmbH, Cologne). pp 731-740 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The design of internal shielding of the THTR a high-temperature reactor now under construction was based on the removal-diffusion method. In particular, computation of heating in the shield layers was performed with the code SABINE. The criteria for this choice are indicated. The sources of error are analysed. The modifications to the program in order to obtain results which meet the engineering requirements on accuracy are described. (FR)

**21395** SOME PROBLEMS ASSOCIATED WITH CALCULATING THE ON-LOAD DOSE RATES ON THE PILE CAP OF AN

ADVANCED GAS COOLED REACTOR. Dutton, L. M. C.; Palit, A. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 771-787 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The design and calculational problem associated with neutron streaming up the annular coolant gap around the fuel stringers of an Advanced Gas Cooled Reactor are discussed. Because of the relative operational movements of the major reactor components, this streaming path is expected to be the main cause of a small but continuous on-load dose rate above the pile cap flooring. The effects of these movements are examined and the resulting variation in the pile cap dose rate is presented. (FR)

**21396** USE OF MODULAR CODES IN A UNIFIED SCHEME OF SHIELD DESIGN PROCEDURES FOR COMMERCIAL REACTOR PLANT. Miller, P. C. (UKAEA Reactor Group, Winfrith, Eng.); Grimstone, M. J.; Packwood, A.; Dawson, J. K.; Pugh, I. G. pp 409-433 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The arguments leading to the development of a new suite of modular codes for the design of commercial reactor shields are outlined. The modular system facilitates the construction of large codes, and the linking of stand-alone codes in the multi-stage hybrid calculations which are of central importance in modern commercial shielding practice. Two levels of approximation have been adopted: quick and relatively accurate codes based on diffusion, albedo and kernel methods for survey studies and shield optimisation; and definitive calculations for marginal situation and final performance assessments accomplished with Monte Carlo methods. The physical models used in these multi-stage calculations have a strong experimental basis involving measurements on zero-energy reactors to determine source spectra and penetration experiments on individual shield features simulated in the fission plate facilities on NESTOR. However, it is the measurements made on operational plant which provide the ultimate test of the overall accuracy, and permit the study of those aspects of the design which cannot be simulated adequately in the laboratory. The capabilities of this comprehensive range of design tools are illustrated with reference to measurements made on operational power reactors including the WAGR, the SGHWR and the concrete vessel plant at Oldbury. (FR)

**21397** RADIATION FLUX AND HEATING LEVELS IN THE HTGR. Engholm, B. A. (Gulf General Atomic Co., San Diego, CA). pp 647-663 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The radiation environment within the prestressed concrete reactor vessel (PCRV) of the High-Temperature, Gas-Cooled Reactor (HTGR) is discussed. The methods used for radiation control and the associated shielding analysis and design procedures are described. The design objectives which have been achieved are: restriction of the fast-neutron fluence to the PCRV liner to less than $2 \times 10^{18}$ nvt (E > 1MeV); reduction of nuclear heating in the PCRV concrete to approximately $1 mW/cm^3$; and limitation of gamma exposure of the inner-tendon lubricant to $5 \times 10^8$ rad. (FR)

**21398** COMPUTATIONAL METHODS FOR GRAPHITE GAS-COOLED REACTORS SHIELDING. Comparison with Shielding Measurements Made During Start-Up Tests. Brisbois, J. (CEN de Saclay, Gif-sur-Yvette, France); Duco, J.; Bourdeau, P.; Chapus, J. pp 1064-1097 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The main shielding problem of the graphite gas-cooled reactors with integrated exchangers, is the possibility of access inside the primary system after shutdown for inspection or repairs of the internal structures. The problem arises essentially above the exchanger which is protected from direct radiation by a shield located in the structure of the supporting area and at the lower end of the peripheral gap provided for cold gas flow and which is a privileged path from neutrons from the reactor core. The computational methods which were developed and their adjustment on mockups are described. Results obtained on the Saint Laurent I, Saint Laurent II and Bugey power plants by shielding measurements during start-up are compared to predictions made from the calculation methods. (FR)

**21399** EXPLOITATION OF A SIMPLIFIED ALBEDO THEORY FOR NEUTRON AND GAMMA-RAY STREAMING IN PRACTICAL DESIGN SITUATIONS. Miller, P. C.; Packwood, A. (UKAEA Reactor Group, Winfrith, Eng.). pp 1098-1130 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The essential requirements of radiation streaming methods for gas-cooled reactor design are discussed. It is shown that these can be most readily achieved by kernel-albedo methods for the simpler geometries but that Monte Carlo albedo methods are necessary for more complicated situations. Acceleration techniques for the Monte Carlo albedo method are discussed. The required accuracy of the albedo data, and the importance of albedo angular dependence terms are indicated by comparison of calculations with various measurements in multilegged ducts. (FR)

**21400** RADIATION PROTECTION AND NUCLEAR ENGINEERING. Jegu, J.; Maire, D.; Poitou, M.; Prouillac, C. (Groupement pour les Activites Atomiques et Avancees, Le Plessis-Robinson, France). pp 149-165 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

After a definition and different considerations about the task of the shielding engineer in the projects, several comparisons between results of anticipated calculations and measurements are presented about the Chinon 3 fuel handling facilities and the Celestin 1 reactor (during starting-up and normal operation for the water loops). The ways through which G.A.A.A. is building up its own computation codes are shown. (FR)

**21401** THE 300 MW THTR NUCLEAR POWER STATION WITHIN THE FRAMEWORK OF NUCLEAR POWER STATIONS WITH GAS-COOLED HIGH-TEMPERATURE REACTORS. Hirschfelder, G. Energ. Tech.; 26: No. 9, 195-200(Sep 1974). (In German).

Following a brief introduction into the basic concepts of nuclear fission and conversion, the advantages of nuclear power plants with gas-cooled reactors are explained. The design data of primary and secondary circuits of various HTRs as well as of the plant components and fuel elements of the THTR 300 are discussed. Finally the safety precautions and radiation exposure, costs and financing are reported. (GE)

## Power Reactors, Non-Breeding, Otherwise Moderated

*Refer also to abstracts 21396, 21845, and 21863.*

**21402** (74-CNA-200, pp 16) NUCLEAR POWER IN QUEBEC. Boulay, C.; Labbe, J. A. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-200.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 2. CANDU program and research installations.

Up to 1985, most power generating capacity added in Quebec will be hydroelectric, except for the 600 MW(e) Gentilly-2 PHW nuclear station, which will begin commercial operation in January 1979. After 1985, however, Hydro-Quebec will add mainly nuclear plants to its system. Experience gained with Gentilly-1 was interrupted in November 1972 by the need to transfer the heavy water to Douglas Point. Startup is scheduled for the autumn of 1974, and the shutdown period has been used for necessary maintenance and tests and for modifications associated (in part) with the flux-distortion problem. Additional absorber rods have been added, and the second safety system based on measurements of thermal power has been replaced by one based on neutron-flux measurements. Some details of the organization and layout of the Gentilly-2 project are given. (INIS)

**21403** (74-CNA-200, pp 17) MAY 1974 REVIEW IN ONTARIO HYDRO'S NUCLEAR PROGRAM. Woodhead, L. W. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 2. CANDU program and research installations.

Pickering Nuclear Generating Station is discussed from the points of view of reliability, economics, causes of lost production, on-power fuelling, and fuel performance. Figures are given for production at Bruce Heavy Water Plant A, and the progress of construction at Bruce Generating Station A is summarized. In

1973, Ontario Hydro's total installed capacity was about 16 CW, of which 14% was nuclear. By 1990 they expect to have 25 CW of CANDU nuclear capacity in Ontario, supplying 65 to 70% of Ontario's electric energy. (INIS)

**21404** (74-CNA-400, pp 9) AECL NUCLEAR POWER MARKETING. Leaist, G. T. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-400.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 4. Export market for nuclear products.

Factors favorable and unfavorable to marketing CANDU reactors abroad are summarized. Advantages to the customer include the possibility of becoming independent in the supply of heavy water and fuel (or of buying Canadian uranium), long-term viability of the system through evolution, and insensitivity of fuel costs to the cost of uranium oxide. Unfavourable factors include commitments to existing national designs in industrial countries such as the United Kingdom and Japan. Undoubtedly, the success of Pickering, and plans for PHW reactors in Quebec (600 MW Gentilly-2) and New Brunswick (2 × 1200 MW), together with the large programme in Ontario, are very favourable to overseas sales. The recent sales to Argentina and the Republic of Korea are discussed, with prospects in other countries. (INIS)

**21405** (74-CNA-500, pp 11) NUCLEAR ENERGY AND MANPOWER. Varughese, J. M. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-500.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 5. Impact of nuclear energy on industry.

The Canadian nuclear programme will necessitate hiring about 700 people per year between 1974 and 2000, most of whom will require training at least in radiation protection and nuclear systems. Ontario Hydro have set up a special school to train nuclear employees. A typical training programme specifies levels of training in: management, science fundamentals, equipment and systems, skills, specific station systems, specific equipment and field training, safety, and radiation protection. It is necessary to schedule training programmes carefully, to have the work force ready for startup. The role of universities, community colleges and schools is discussed. A chart shows the organization of Ontario Hydro's nuclear operations. (INIS)

**21406** (74-CNA-600, pp 20) BRUCE NUCLEAR POWER DEVELOPMENT: A COMMUNITY RELATIONS EXPERIENCE REVIEW. Durand, J. J.; Horton, S. G. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-600.

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 6. Nuclear energy and the public.

Initially, local reaction to the nuclear development at Bruce was favorable. Surprisingly, local opposition has centered on the heavy-water plant. This came about because Ontario Hydro was obliged to purchase Inverhuron Park (a wilderness camping area) because of possible nuisance from hydrogen sulfide leaks. There has been much discussion about the necessary expropriation of land for electrical transmission lines. Finally, an opposition group calling itself CANTDU has appeared. (INIS)

**21407** (NP-20289) OECD HALDEN REACTOR PROJECT. Fourteenth Annual Report, 1973. (Organization for Economic Co-Operation and Development, 75 - Paris (France)). 1974. 101p.

Activities at the OECD Halden Reactor Project in 1973 are summarized. The work covered control methods and computer applications and light-water reactor fuel research. Reactor operation and administrative activities during the period are described. (JWR)

**21408** NEUTRON SHIELDING STUDY FOR A HEAVY WATER PRESSURE TUBE REACTOR. Boldori, P. (Centro Informazioni Studi Esperienze, Milan); Giorcelli, M.; Lauer, H.; Nicks, R.; Penkuhn, H.; Perlini, G.; Ponti, C. pp 1047-1063 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The results of a study performed for the design of the neutron shield of the prototype CIRENE reactor (a heavy water pressure tube reactor) are reported. The attenuation properties of this shield have been experimentally investigated with a few mockups which have been irradiated in the EURACOS facility. This experience served the purpose of testing several codes and of choosing and implementing a method of calculation suitable to the neutron shield of the reactor. The experience points out the main features of the neutron transport along an iron cylinder surrounded by water, and provides useful information to the shield design. (FR)

**21409** THERMOHYDRAULIC CALCULATION OF GAS-COOLED REACTORS. Hermansky, B. Acta Polytech. (Prague), IV; No. 3, 65-74(1973). (In Russian).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

A mathematical model is formulated describing the stationary states of the A-1 heavy-water reactor at various stages of operation. The description of the spatial distribution of temperature sources assumes that the heat generation resulting from uranium fission is proportional to the thermal neutron flux. Included in the pressure loss calculation are losses at the fuel channel inlet, losses due to friction and local resistance, losses at the fuel channel outlet, and coolant acceleration losses resulting from the decrease in specific weight due to heating and pressure drop, as well as losses resulting from upward pressure compensation. The program STATIC is described, written in FORTRAN IV, permitting the determination of the temperature field in the core if the reactor output and other parameters are given, and determining the thermal output of the reactor if the maximum permissible surface temperature is given. (INIS)

**21410** SIGNIFICANCE OF FIRST CZECHOSLOVAKIAN NUCLEAR ELECTRIC STATION IN DEVELOPMENT OF NUCLEAR POWER. Goldschmidt, J. Energetika; No. 7, 273-276(Jul 1974). (In Slovak).

Consideration of heavy-water reactors, and of the characteristics and state of development of the A-1 type of reactor indicates that the most promising avenue for development of nuclear power is the light water reactor. (auth)

## Power Reactors, Breeding

*Refer also to abstracts 19206, 20270, 21350, 21366, 21766, 21767, 21774, 21775, 21777, 21779–21781, 21783–21785, and 21801.*

**21411** (ANL-7981) EBR-II REACTOR OPERATION SIMULATOR: VOLUME I. A Description of EROS. Kaganove, J. J.; Dean, E. M.; Campise, A. V. (Argonne National Lab., Ill. (USA)). Aug 1974. Contract W-31-109-eng-38. 67p. AT.

The basic objective of the EROS code is to provide the necessary and sufficient dynamic simulation of normal and off-normal EBR-II reactor operating conditions. EROS solves the space-independent reactor-kinetics equations and computes the temperature-induced reactivity feedback in the system by solving a set of equations representing the spatial heat and mass transfer. Up to 20 channels or 1000 feedback equations are available for modeling a reactor-system feedback network. Trips can be initiated by delayed signals from instruments that sense any quantity calculated—e.g., power inverse period, reactivity, or temperature. (auth)

**21412** (ANL-8116) DEVELOPMENT AND USE OF GAMMA SCANNING TO DETERMINE RATES OF FISSION-GAS RELEASE FROM NUCLEAR FUELS. Claar, T. D.; Hayner, G. O.; Laug, M. T.; Bono, R. W. (Argonne National Lab., Ill. (USA)). Oct 1974. Contract W-31-109-eng-38. 60p. AT.

A nondestructive technique has been developed and used for quantitative determination of the activity of radioactive $^{133}Xe$ fission gas in the gas-plenum regions of nuclear-reactor fuel elements. A lithium-drifted germanium gamma-detector system was used to count the 0.081-MeV photons emanating from the fuel element plena as a result of $^{133}Xe$ radioactive decay after the fuel elements had been discharged from the EBR-II reactor to the shielded examination facility. The gamma-scanning system was calibrated by measuring the intensity of the 0.081-MeV gamma radiation in a number of EBR-II driver fuel elements and then correlating this intensity with the $^{133}Xe$ concentration in each plenum as determined by mass-spectrometric analysis of the gas recovered after puncturing. Experimental $UO_2-PuO_2$ mixed-oxide elements then were gamma-scanned for $^{133}Xe$ activity as part of their nondestructive examination. The results for activity, which were based on the previous calibration, were then compared with the transport-theory calculations of fission rate to obtain $^{133}Xe$ release-to-birth ratios as a function of element design and operating conditions. (auth)

**21413** (BNWL-B-364) SEISMIC ANALYSIS AND TESTING PLAN FOR GENERAL ATOMIC GAS-COOLED FAST REACTOR

CORE ELEMENTS. Henager, C. H.; Anderson, W. E.; Liu, S. N. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1975. Contract AT(45-1)-1830. 29p. Dep. NTIS $4.00.

The purpose of this analysis and test plan is to outline analysis methods and important variables to be included in evaluating the effects of seismic events on the GCFR fuel assemblies, control fuel assemblies, and blanket assemblies. This plan is directed toward accomplishing analysis, testing and documentation required for AEC licensing requirements. (auth)

**21414** (CEA-CONF-2663) SPECIAL INSTRUMENTATION FOR PHENIX. Part III. Hydrogen Detection. Lions, N.; Cambillard, E.; Pages, J. P.; Chantot, H.; Buis, H.; Baron, J.; Langlois, G.; Lannou, L.; Viala, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France); CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France); Electricite de France, 78 - Chatou). 1974. 4p. (CONF-740318-8). Dep. NTIS (US Sales Only) $4.00.

From conference on fast reactor power stations; London, UK (11 Mar 1974).

The small water leakages into sodium in the steam generators of Phenix reactor are detected by measuring the hydrogen concentration in the liquid metal. The hydrogen is produced by the sodium-water reaction. The faulty module can also be located by the hydrogen detection system. A description is given of the hydrogen detection system, and testing and calibration of the system is discussed. (DG)

**21415** (CONF-740903-14) REACTIVITY FEEDBACK COEFFICIENTS FOR USE IN CRBR TRANSIENT ANALYSES. Mayo, W.; Doncals, R. A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). [nd]. 12p. Dep. NTIS $4.00.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

Reactivity feedback coefficients for the Clinch River Breeder Reactor (CRBR) are developed for use in system transient analyses, reactor stability analyses, and accident analyses. The calculational methods and associated uncertainties are described and design problem areas are delineated. (auth)

**21416** (CONF-740903-15) BREEDING RATIO AND DOUBLING TIME CHARACTERISTICS OF THE CLINCH RIVER BREEDER REACTOR. Lake, J. A.; Doncals, R. A.; Rathbun, R. W.; Robinson, H. C. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). [nd]. 12p. Dep. NTIS $4.00.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

The Clinch River Breeder Reactor, per the current design, will have a breeding ratio of 1.20 at the start-of-life and 1.23 at the end of the first cycle. This value is expected to drop to approximately 1.12 in the equilibrium cycles if the present type fuel and blanket assembly designs are retained. However, with reasonably anticipated advances in fuel design technology, a breeding ratio of at least 1.20 can be maintained throughout the life of the plant. Potential equilibrium fuel assembly designs have been proposed which will accomplish this objective as well as achieve the design goal burnup of 150,000 MWd/T. CRBR, with a peak linear power rating of 14.5 kW/ft and an equilibrium breeding ratio of 1.20, has a compound system doubling time of approximately 34 years. (auth)

**21417** (CONF-740903-16) NUCLEAR DESIGN OF THE CLINCH RIVER BREEDER REACTOR SYSTEM. Riley, D. R.; Buhl, A. R.; Dickson, P. W.; Doncals, R. A.; Greebler, P. W. (USAEC, Washington, D. C.; Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.; General Electric Co., Sunnyvale, Calif. (USA)). [nd]. 16p. Dep. NTIS $4.00.

From meeting on advanced reactors; physics, design and economics; Atlanta, Georgia, USA (8 Sep 1974).

A reactor system design description is presented including the following: nuclear data, computation methods, and critical experiments; fuel cycle aspects; control considerations; breeding characteristics; nuclear design impact on safety parameters; and core monitoring requirements. (JWR)

**21418** (COO-2250-11) MIT LMFBR BLANKET RESEARCH PROJECT. Quarterly Progress Report, July 1, 1974 - September 30, 1974. Driscoll, M. J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 1974. Contract AT(11-1)-2250. 12p. Dep. NTIS $4.00.

Progress in the experimental and theoretical investigation of LMFBR breeding blanket design parameters is reported. Data from foil activation traverses conducted in Blanket Mockup No. 4 are presented together with measured and calculated values for the integral spectral indices of the blanket. (DG)

**21419** (EURFNR-1179) REACTION BEHAVIOR OF FISSION PRODUCTS IN CARBIDE AND NITRIDE FUEL BASED ON SIMULATION INVESTIGATIONS. Smailos, E. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Mar 1974. Translation of KFK-1953. 174p. Dep. NTIS $11.75.

Work performed under United States-Euratom Fast Reactor Exchange Program. Thesis. Submitted to Univ., Karlsruhe, Ger.

The reaction behavior of the important solid fission products was experimentally investigated in nitride and carbide fuels. In the nitride fuel, the quasibinary mononitride systems Un-ZrN, Un-YN, Un-LaN, UN-CeN, UN-PrN, and UN-NdN show that UN exhibits complete solid solubility at high temperatures (1800-2000°C) with ZrN and rare earth metal nitrides. Based on these results and thermodynamic stability data, fission product reactions in mixed nitride fuel (U,Pu)N at high burnup are deduced. The consequences of the reaction behavior of the fission products on the nitrogen chemical potential in (U,Pu)N are estimated. In the carbide fuel the reactions between hypostoichiometric (C/U < 1) and hyperstoichometric (C/U > 1) fuel and various fission products (Zr, Mo, Ru, Rh, Pd, Y, La, Ce, Pr, Nd, Sm, Sr) were investigated. The simulated burnup was 10, 20 and 30%. The likely fission product reactions in mixed carbide fuel (U,Pu)C at high burnup are deduced on a basis similar to that in the nitride fuel. The consequences of the reaction behavior of the fission products on the carbon chemical potential in (U,Pu)C are estimated. 138 references. (auth)

**21420** (HEDL-TME-71-98) INDEPENDENTLY ACTUATED CORE RESTRAINT MECHANISM. Waymire, G. R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 28 Jun 1971. Contract AT(45-1)-2170. 32p. AT.

Design criteria for a through-the-head actuated core restraint mechanism utilizing a double bell crank are presented. (JWR)

**21421** (HEDL-TME-72-129) LMFBR REACTION RATE AND DOSIMETRY. 5th Quarterly Progress Report, June-August 1972. McElroy, W. N. (comp.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1972. Contract AT(45-1)-2170. 132p. Dep. NTIS $9.75.

The ILRR program goal of ±5% to 10% (1σ) accuracy for radiochemistry measurements appears to have been satisfied for most non-fissions foils for the CFRMF irradiations accomplished to date. Final reaction rate measurements and error assignments for the ANC-I, ANL-I, ARHCO-I, and HEDL-I non-fissions foil sets are documented. An ANC evaluated set of nuclear parameters has been adopted by all participating laboratories for this work. All laboratory results are summarized and compared. Two results are given for ANC, based on measurements by two separate counting laboratories. (auth)

**21422** (KFK-1274/2) FAST BREEDER PROJECT. Second Quarterly Report, 1974. Hueper, R. (comp.). (Kernforschungszentrum Karlsruhe (F.R. Germany). Projekt Schneller Brueter). Oct 1974. 262p. (In German). (EUR-4979d). Dep. NTIS (US Sales Only) $16.25.

Information is presented concerning the development of $PuO_2$-$UO_2$ fuel pins, irradiation testing of steel clad $PUO_2$-$UO_2$ fuel pins, sodium corrosion of reactor materials, $PuO_2$-$UO_2$ fuel cycle, reactor physics, safety and instrumentation, and development of SNR components. (DCC)

**21423** (LA-5798-PR) EXAMINATION OF FAST REACTOR FUELS AND FBR ANALYTICAL QUALITY ASSURANCE STANDARDS AND METHODS. Quarterly Report, July 1-October 31, 1974. Baker, R. D. (comp.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1974. 14p. Dep. NTIS $4.00.

The project for the examination and comparison of the effects of neutron irradiation on LMFBR Program fuel materials is described. Unirradiated and irradiated materials will be examined. Capabilities are established and are being expanded for providing conventional preirradiation and postirradiation examinations. Nondestructive tests will be conducted in a hot cell facility specifically modified for examining irradiated prototype fuel pins. (auth)

**21424** (NDS-17(Vol.1)) PROJECT PLANS PROGRAM A, PHASE I. LMFBR Large Valve Technology Development to the Atomic Energy Commission, San Francisco Operations Office. Volume I. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1969. 43p. Dep. NTIS $5.25.

The overall objective of Phase I is to perform the engineering design, analysis, and supporting work required to produce: (1) complete, preliminary designs of three concepts for each of four different valve types; and (2) a preliminary version of the engineering guide. The planned duration of Phase I is eight months. The design concepts that appear to be the most promising for development will be selected early in the program and actual design will start without delay. For convenience of control, the design work will be separated into preliminary, refinement, and final phases. Technical analysis and other support effort will be utilized by the valve designers as soon as required. (auth)

**21425** (ORNL-5005) HIGH-TEMPERATURE STRUCTURAL DESIGN METHODS FOR LMFBR COMPONENTS QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1974. Greenstreet, W. L.; Corum, J. M.; Pugh, C. E. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 146p. AT.

Information is presented concerning exploratory studies on Type 304 stainless steel; constitutive equation development; failure studies; development, evaluation, and distribution of structural analysis methods and tools; inelastic structural tests and associated analysis; and design criteria. (DCC)

**21426** (ORNL-5018) PROGRAM PLAN FOR DEVELOPMENT OF MOLTEN-SALT BREEDER REACTORS. McNeese, L. E. (Oak Ridge National Lab., Tenn. (USA)). Dec 1974. W-7405-eng-26. vpp. Dep. NTIS $13.60.

The program for development of molten salt breeder reactors includes: development of structural metal for primary and secondary circuits; fuel processing research; fuel-processing materials development; chemical research and development; analytical research and development; reactor safety research; reactor design and analysis; graphite development; reactor technology development; maintenance planning; instrumentation and controls development; test reactor mockup; test reactor; and a demonstration reactor. (JWR)

**21427** (ORNL-TM-4670) TEMPERATURE DISTRIBUTION IN A 19-ROD SIMULATED LMFBR FUEL ASSEMBLY IN A SCALLOPED DUCT (FUEL FAILURE MOCKUP BUNDLE 1A): RECORD OF EXPERIMENTAL DATA. Fontana, M. H.; Gnadt, P. A.; Kress, T. S.; MacPherson, R. E.; Parsly, L. F.; Wantland, J. L. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 263p. AT.

Experimental data obtained from Fuel Failure Mockup (FFM) bundle 1A, which simulated the configuration and power level of the Fast Test Reactor (FTR) fuel subassembly are presented. Bundle 1A consisted of 19 electric cartridge heaters with outside diameters of 0.230 in. spaced by 0.056-in. wire wraps on a 12-in. pitch and enclosed in a scalloped duct. The purpose of this test series was to obtain thermal-hydraulic data for use in design of the FTR core. A description of the system and of the experimental procedures, a discussion of the data-reduction procedures, and tabulated data from the experiments performed in this series are included. (auth)

**21428** ACTIVITY AND SHIELDING OF THE ARGON CIRCUIT OF A FAST POWER REACTOR. Costa, L.; de Fremont, R. (CEN de Cadarache, Saint-Paul-les-Durance, France). pp 881-897 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The activity of rare gas fission products in the blanket gas of a fast power reactor is calculated for the main operating conditions, taking into account the presence in the core of a certain amount of cladding failures. The corresponding shielding is calculated. The analysis of the results shows the main consequences of rare gas contamination on the conception of the blanket gas circuit and on the allowable amount of cladding failures in the case of a clean reactor. (FR)

**21429** INTERCOMPARISON OF DIFFERENT METHODS TO CALCULATE NEUTRON TRANSPORT ALONG SODIUM DUCTS. Amin, E. (Univ., Stuttgart); Hehn, G.; Schmidt, F.; Diettrich, O.; Futtermenger, W.; Vogt, H.; Groenefeld, G.; Vossebrecker, H.; Herrnberger, V. pp 1427-1443 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

An intercomparison has been completed for programs capable of dealing with two-dimensional shielding problems. The programs used are the SN-program DOT II, the group Monte Carlo programs MORSE-K and TIMOC-71, the point Monte Carlo programs UNC-SAM2 and TRAPAR and a modified diffusion code DLS. As a test example the streaming of neutrons along a sodium coolant pipe of a fast breeder reactor was chosen. The comparison was made with the following quantities: a) axial and radial distribution of fluxes and reaction rates, b) neutron energy spectra at different penetration depths, and; c) machine time needed. (FR)

**21430** INVESTIGATION OF THE DISTRIBUTION OF INTERMEDIATE NEUTRONS AND CAPTURE GAMMA RADIATION IN FAST REACTOR SHIELDING. Bolyatko, V. V.; Kulakovsky, M. Ya.; Mashkovich, V. P.; Sinitsyn, B. I.; Suvorov, A. P.; Troshin, V. S.; Khokhlov, V. F.; Tsypin, S. G. (Inst. of Physical Energy, Obninsk, USSR). pp 1388-1426 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In English and Russian)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

A complex experimental investigation of space distributions and energy spectra of intermediate neutrons and secondary gamma-radiation is performed for a vast region of shielding media and shields with irregularities by means of especially designed intermediate neutrons converter at the B-2 beam of the BR-5 fast reactor. Experimental data are compared with the results of calculations using $2D_5P_5$ approximation of discrete ordinates method for homogeneous media and parametric methods for shields with irregularities. (FR)

**21431** SHIELDING OF PHENIX HANDLING FACILITIES AND AUXILIARY CIRCUITS. Culambourg, J. (CEN de Saclay, Gif-sur-Yvette, France); Godot, B.; Jegu, J. pp 923-936 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The shielding problems, except the core ones, in the PHENIX reactor design are described. After giving the strength of various radioactivity sources, fuel handling through a shielded lock chamber, exchangers, pumps, transfer arm and control rods mechanisms handling in two shielded mobile casks are reviewed. Running and maintaining the circuits for purification of sodium coolant and for purification of the argon plenum are described. (FR)

**21432** LMFBR RADIATION TRANSPORT METHODS DEVELOPMENT. Mynatt, F. R.; Gritzner, M. L.; Williams, L. R.; Clifford, C. E. (Oak Ridge National Lab., TN). pp 788-811 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The elements of a shielding program based on a fundamental approach are discussed with a brief evaluation of the present status of the technology. A procedure is presented for utilizing the best features of Monte Carlo, discrete ordinates, and diffusion theory is coupled calculations providing good accuracy at minimum expense. As an example, results are presented from a four-step coupled two-dimensional discrete ordinates calculation for determination of the neutron and secondary gamma-ray dose rates in the FTR head compartment. An assessment of computational methods development plans is presented. (FR)

**21433** NEUTRON STREAMING ALONG THE PENETRATION OF A TWICE BENT SODIUM PIPE. Diettrich, O. (Commission of the European Communities, Ispra, Italy); Marchal, A.; Nicks, R.; Perlini, G.; Mueller, K.; Vossebrecker, H.; Oliva, A. pp 1148-1165 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

Measurements and Monte Carlo calculations on the neutron attenuation along a large twice bent sodium pipe penetration through graphite and concrete shields, which is typical for loop type LMFBR's, are presented. The agreement between the measured and calculated flux-densities is satisfactory both for the TIMOC 71-code and for the ALBEMO-code (based on the albedo-concept). (FR)

**21434** DEVELOPMENT OF THE TWO-DIMENSIONAL SHIELDING CODE RASC-2D AND ITS APPLICATION. Tanaka, Y.; Suzuki, I.; Ohtani, N. (Kawasaki Heavy Industries, Ltd., Tokyo). pp 611-623 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The two-dimensional shielding code RASC-2D is described. The code which is based on the removal-diffusion theory has been developed for the analysis of LMFBR shields taking into account of l a-few-group approximation, suitable treatment of fission sources and empirical adjustment of removal cross-sections. Its usefulness with the practical computing time and the reasonable accuracy is shown in the application to the JOYO main shield. (FR)

**21435** SHIELDING OF COMMERCIAL FAST REACTORS. Brindley, K. W. (Nuclear Power Group Ltd., Risley, Eng.). pp 68-86 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1976).

Shielding problems encountered during the design of the 250MW(e) PFR and 1300MW(e) CFR are described together with the theoretical and practical methods of solution. Design criteria are given for activation of components in the primary circuit

and the secondary coolant, and for irradiation damage to structural materials. Contamination in the primary circuit with fission and corrosion products from the core is taken into account and also the district hazard from the release of secondary sodium. Consideration is given to the problems of shielding irradiated fast reactor fuel. (FR)

**21436** PROBLEMS RELATED TO THE DEFINITION OF THE SHIELDING OF A LARGE FAST POWER REACTOR. Moreau, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). pp 103-121 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1976).

Solutions for the shielding of a 1000MW(e) power plant in the same technological line as Phenix are given. They have been evaluated with a monodimensional transport code. The choice is based on the comparison of their efficiency towards neutrons and on the consequences of their characteristics on the conception of the reactor tank. A few economical considerations give an idea on the influence of the choice in shielding on the cost of the power plant. The problem of the optimization possibilities is approached from the designer's point of view. (FR)

**21437** GAS-COOLED FAST REACTOR SHIELD DESIGN. Haschke, D.; Ganapol, B.; Henninger, R.; Maeder, C. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 122-134 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1976).

A design approach for the internal radial neutron shield for a gas-cooled fast reactor is presented. Models of embrittlement and their use, accuracy of various approximations for determining the neutron flux, the effect of different shielding materials and various configurations, and some economic aspects are discussed. (FR)

**21438** SHIELDING PROBLEMS IN THE PEC REACTOR. Cicognani, G. (CNEN, Bologna); Tavoni, R.; Travaglini, N.; Corbo, M.; Farinelli, U.; Tondinelli, L.; Canali, U.; Nicks, R.; Penkuhn, H.; Ponti, C. pp 87-102 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1976).

The PEC reactor is a sodium cooled fast reactor designed mainly for testing fast reactor fuel elements. Its peculiar geometry, also due to the presence of the test zone, originates some particular shielding problems, besides those typical of sodium cooled fast reactors. The problems encountered in the design of the shields of the reactor, the extensive set of calculations that have been performed, and the critical points that have been identified are presented. (FR)

**21439** DESIGN OF THE PHENIX REACTOR SHIELDING. Culambourg, J.; Devillers, C.; Le Dieu de Ville, A.; Nimal, J. C. (CEN de Saclay, Gif-sur-Yvette, France). pp 58-67 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French)

From 4th international conference on reactor shielding; Paris, France (9 Oct 1976).

The shielding studies of Phenix reactor since the preliminary ones to the final realization are presented. (FR)

**21440** STATE-OF-THE-ART OF LIQUID METAL FAST BREEDER REACTORS. Palmer, R. S. (General Electric Co., Sunnyvale, CA). pp 15.1-15.30 of Frontiers of Power Technology. Stillwater, OK; Univ. of Oklahoma (1972).

From frontiers of power technology meeting; Stillwater, Oklahoma, USA (11 Oct 1972). See CONF-7210125-.

Progress in LMFBR development is reviewed, and the areas in which development efforts are being concentrated are enumerated. LMFBR components are illustrated and discussed, and planning and design concepts are discussed. (DG)

**21441** LEVEL PROBE, PARTICULARLY FOR A LIQUID METAL. Barbier, G. (to Commissariat a l'Energie Atomique). French Patent 2,169,711/A/. 24 Dec 1971. 11p. (In French).

A level probe is described, in particular for liquid metals, comprising, inside a tight glove-finger dipped in the liquid metal, a primary winding energized by an external voltage source and a secondary winding adapted to deliver an output signal, said windings being mutually electrically coupled and wound as a whole about an axial core, in such a manner that the coupling of said windings is altered whenever the liquid metal surrounding the glove-finger happens to be at the level of one said windings, thus modifying the output signal. The probe is characterized in that its axial core is made of magnetic material and its primary winding is energized by a low frequency alternating voltage. (FR)

**21442** IMPROVEMENTS IN ENERGY GENERATING THERMAL CYCLES USING $CO_2$. (to Societe Babcock-Atlantique). French Patent 2,178,386/D/. 30 Mar 1972. 12p. (In French).

The expanded $CO_2$ is de-superheated and partially caused to condense, while the liquid and gas-phases are re-compressed separately by means of a pump and a compressor. Condensation is achieved by thermal exchange with a water–ice mixture fed from a stock provided by a refrigerator, the compressor of which operates at slack hours exclusively. The method can be applied to the use of the thermal energy generated by constant-rate sources, in particular nuclear reactors. (FR)

**21443** REACTIVITY FROM POWER SPECTRAL DENSITY MEASUREMENTS WITH CALIFORNIUM-252. Pare, V. K.; Mihalczo, J. T. (Oak Ridge National Lab., TN). Nucl. Sci. Eng.; 56: No. 2, 213-218(Feb 1975).

A theory is developed for the cross-power spectral densities between the signal from an ionization chamber containing a $^{252}Cf$ neutron source, which provides the initiation of fission chains in a reactor or neutron multiplying assembly, and the signals from detectors of particles from fission chains in the reactor. Previously derived spectral densities between two detectors are modified to include the effects of the inherent and $^{252}Cf$ source in the reactor. Calculations of the amplitude of the coherence function for noise measurements, both conventional and $^{252}Cf$, for the reactor at the Fast Flux Test Facility are presented and can be used to estimate the time required for a measurement with a given precision. The equivalence between the expressions developed here and those previously developed for time-domain measurements of this type is also shown. (auth)

**21444** THERMAL ANALYSIS OF HOT SPOTS ON FAST-REACTOR FUEL CLADDING DUE TO DEPOSITION OF LOW-CONDUCTIVITY MATERIALS. Ishii, M.; Chawla, T. C. (Argonne National Lab., IL). Nucl. Sci. Eng.; 56: No. 2, 188-195(Feb 1975).

The formation of hot spots in fuel cladding due to the deposition of a low-conductivity heat-generating fuel or due to fission-gas-jet impingement is a very credible event and can significantly influence the probability for slow fuel-failure propagation in a subassembly of a liquid-metal fast breeder reactor. By assuming steady-state conditions, a general expression is obtained for the temperature distribution in these hot spots. As special cases, expressions are obtained for temperature distributions in hot spots caused by fission-gas-jet impingement and partial or total channel blockages by fuel debris. A partial verification of the model for thermal analysis is provided by comparing predictions for the temperature distribution in the gas-jet impingement region to the available experimental data. (auth)

**21445** SCHEVCHENKO SEAWATER DESALTING PLANT. Sansone, M. M. Com. Naz. Energ. Nucl., Notiz.; 20: No. 11, 57-60(Nov 1974). (In Italian).

A description of the Schevchenko facility for the production of fresh water from the sea, which includes a nuclear power plant equipped with a BN 350 fast reactor, is presented. (auth)

## Research, Test, and Experimental Reactors

*Refer also to abstracts 21427, 21750, 21846, and 21849.*

**21446** (AAEC/TM-559) PRELIMINARY ASSESSMENT OF AN S.G.H.W. TYPE RESEARCH REACTOR. Bicevskis, A.; Chapman, A. G.; Hesse, E. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1970. 32p. Dep. NTIS (US Sales Only) $4.75.

Declassified Jan 1975.

A preliminary design study has been made of a research reactor, based on the enriched S.G.H.W.R. concept, to be used for power reactor fuel irradiation, isotope production, basic research, and training in nuclear technology. A reactor physics assessment established a core size which would allow uninterrupted operation for the required irradiation period consistent with low capital and operating costs. A design was selected with 24 channels, a $D_2O$ calandria diameter of 2.7 m and an overall core height of 4.0 m. The capital cost was estimated as $750,000 for the fuel and $1,600,000 for the moderator, the refueling cost being $340,000 per annum. A thermal design study showed that the fission heat of 65 MW could be transmitted to pressurized light water at 200 lb/in.$^2$ abs. and rejected to seawater in two conventional U-tube heat exchangers. The basic design is flexible and can be adapted to meet many special requirements. (auth)

**21447** (AE-494) HIGH TEMPERATURE THERMOCOUPLE APPLICATIONS IN THE R2-REACTOR AT STUDSVIK, SWEDEN.

Rohne, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov 1974. 21p. Dep. NTIS (US Sales Only) $4.25.

In the experimental rigs for the irradiation of coated particles at temperatures up to 1600°C several types of thermocouple have been used: Platinum-Platinum 10% Rhodium, Tungsten 5% Rhenium-Tungsten 26% Rhenium, Tungsten 3% Rhenium-Tungsten 25% Rhenium and Platinum 0.1% Molybdenum-Platinum 5% Molybdenum. Specifications, installation and behavior during irradiation (failure rate and decalibration) are discussed. Although only a few thermocouples of the Platinum-Molybdenum type have been tested, this seems to be the most suitable for temperature measurements in graphite up to 1500°C in view of the low decalibration rate. The decalibration is almost linear with thermal flux and is about +2% at a thermal neutron fluence of $8 \cdot 10^{24}$ $m^{-2}$ and at about 900°C. (auth)

**21448** (AGC-2652) ANALYSIS OF THE FAST NEUTRON AND GAMMA RAY SPECTRUM FOR LPR MECHANICAL TEST 901. (Aerojet-General Corp., Azusa, Calif. (USA)). 30 Sep 1963. 42p. Dep. NTIS $5.25.

Test components from the NERVA Propellant Feed System, including a tank shut-off valve, a turbine power control valve, the turbopump bearings, and assorted flanges and seals, are to be irradiated at cryogenic hydrogen conditions. The analytical results reported are a calculated description of the nuclear environment produced by the Aerospace Systems Test Reactor at General Dynamics/Ft. Worth in the LRP Mechanical Radiation Test No. 901. The gamma ray and fast neutron fluxes and the gamma ray heating rates were calculated for selected points throughout the test components using the Los Alamos QAD Code. (auth)

**21449** (AGN-8347) FAST FLUX TEST FACILITY CENTRAL MAINTENANCE FACILITY CONCEPTUAL STUDIES. Progress Report. (Aerojet-General Corp., San Ramon, Calif. (USA). Nuclear Div.). Jan 1970. 67p. Dep. NTIS $6.50.

Background data on which will be based the concept selection for the Fast Flux Test Facility Central Maintenance Facility are presented. Existing government facilities capable of radioactive maintenance were studied and those which could be adapted to FFTF requirements were identified and described. Use of off-site facilities will be limited because of certain facility limitations in lift capacity, hook height and alpha contamination spread problems. Sodium removal techniques applicable to FFTF were identified and described. Decontamination studies were performed and it was tentatively decided that several techniques may be adapted for FFTF. Preliminary CMF layouts were prepared and large maintenance cask and floor valve plans were initiated. These are key items in development of a complete concept. 15 references. (auth)

**21450** (BNWL-B-75) PROPOSAL TO IRRADIATE POWER BURST FACILITY FUEL ELEMENTS UNDER STEADY STATE CONDITIONS IN THE ETR M-3 LOOP. Marshall, R. K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1971. Contract AT(45-1)-1830. 49p. Dep. NTIS $5.50.

Plans for a steady-state irradiation of Power Burst Facility (PBF) fuel elements in the ETR M-3 loop are described, and the design analysis of the test assembly is presented. The test assembly consists of a 3 × 3 rod array with the rods located on a 0.792 inch pitch. Seven of the positions in the array are occupied by PBF fuel rods and two are occupied by dummy rods. The dummy rods occupy the corner positions nearest to the reactor. The radial flux gradient across the facility causes the power generated in fuel rods located in these positions to exceed the maximum design heat rating. The maximum design heat rate is 14.5 kW/ft. The test flow velocity is 11 ft/sec, the loop operating pressure is 600 psi, and the coolant inlet temperature is 200°F. The PBF production rod fuel contains 30.6 wt% $UO_2$ (18.3% enriched), 62.3 wt% $ZrO_2$, and 7.1 wt% CaO. (auth)

**21451** (GKSS-74/E/31) REPAIR WORK IN THE OPERATING POOLS OF A SWIMMING POOL REACTOR. Henning, K.; Roebert, G. A.; Witte, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (F.R. Germany)). 1974. 5p. (In English, German). INIS.

Published in Kerntechnik, 1974, v. 16(5), p. 208-212.

Repair work on the beam tubes of the reactor FRG-1 and the replacement of the shutoff gate valves in the inlet and outlet lines, located in the pipework channel running under the reactor pools, are described. It proved possible to carry out this work without excessive radiation exposure of personnel. The repair work on the beam tubes was carried out by divers, in order to make use of the shielding effect of the pool water. This technique can also find application in nuclear power stations. (auth)

**21452** (HEDL-TME-71-22) FUNCTIONS AND REQUIREMENTS FROM THE SYSTEM DESIGN DESCRIPTIONS OF THE FAST FLUX TEST FACILITY. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1 Feb 1971. Contract AT(45-1)-2170. 289p. AT.

Descriptions are presented of the functions and requirements of the reactor, reactor systems, refueling and maintenance systems, plant protection systems, and the various auxiliary systems at the Fast Flux Test Facility. (JWR)

**21453** (HEDL-TME-71-46) PARAMETER LISTS FROM THE SYSTEM DESIGN DESCRIPTIONS OF THE FAST FLUX TEST FACILITY. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1971. Contract AT(45-1)-2170. 97p.

**21454** (HEDL-TME-72-28) PECT-2 ANALYSIS OF THE H-3 TRANSIENT TEST. Bard, F. E.; Dutt, D. S. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1972. Contract AT(45-1)-2170. 27p. Dep. NTIS $4.50.

The results of a pretest deformation analysis of the H-3 Fuel Failure experiment are presented. The results show a 50% chance of failing the PNL-17-24 fuel pin during the test. 16 references. (auth)

**21455** (HEDL-TME-74-53) EVALUATION OF THE MODIFIED SOURCE MULTIPLICATION TECHNIQUE FOR SUBCRITICAL REACTIVITY ASSESSMENTS IN FTR. Fleischman, R. M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Oct 1974. Contract AT(45-1)-2170. 119p. AT.

The Modified Source Multiplication (MSM) method, the reference method for inferring subcritical reactivities in the FTR, is evaluated using FFTF critical experiments data. The experiments and analysis emphasize the application of the method to the FTR environment and operating mode. Comparison of measured reactivities with MSM results using various detector locations is presented in detail. Direct comparisons of calculated count rates and reactivities with measured values are also given. (auth)

**21456** (KFK-2037) DEVICE FOR THE REPLACEMENT OF $UO_2$-$PuO_2$ TEST FUEL RODS WITH CLADDING DEFECTS AT THE FR2 REACTOR. Jannakos, K.; Hain, K. (Kernforschungszentrum Karlsruhe (F. R. Germany). Abt. Reaktorbetrieb und Technik). Aug 1974. 16p. (In German). INIS.

10 figs.; 1 ref.

Special devices have been developed for handling plutonium bearing fuel element specimens with planned and unplanned cladding defects irradiated in a steam contamination loop at FR2. These special devices make it possible to carry out work required for the replacement of fuel element specimens while protecting from alpha contamination the reactor environment and its standard handling equipment, such as the refueling machine. This report describes the tasks, implementation and experience obtained in the use of the special devices. (auth)

**21457** (KFK-2068) HIGH-PRESSURE CAPSULES FOR IRRADIATION OF FUEL SWELLING SAMPLES IN FR2. Haefner, H. E. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Oct 1974. 45p. (In German). Dep. NTIS (US Sales Only) $5.25.

A high-pressure capsule with the load applied on all sides of the sample through an outer gas pressure (max. 500 bar) is described. It is intended to set at small pellet stacks (about 6 mm in diameter) placed in this capsule fuel surface temperatures between 1000 and 1500°C and sample loads up to 5 kp/$mm^2$. The amount of swelling of the fuel is detected by assessment of the density of the individual pellets in the post-examination performed in the hot cells. The thermodynamic and mechanical design as well as safety considerations are described. 7 references. (auth)

**21458** (KFKI-74-69) MEASUREMENT OF THE DOSE RATE DISTRIBUTION WITH CALORIMETERS AND MEASUREMENT OF THE TEMPERATURES OF SAMPLES AND WALLS OF THE FUEL ELEMENTS IN THE WWR-SM REACTOR. Bod, L.; Varkoni, L.; Vizdosh, G.; Balog, Sh.; Frankl, L. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Sep 1974. 47p. (In Russian). (CONF-740963-1). Dep. NTIS (US Sales Only) $5.50.

From symposium on operation and use of research reactors; Predeal, Romania (30 Sep 1974).

The absorbed dose rate was measured in a few vertical irradiation channels in two core configurations with heat-flow calorimeters developed for the WWR-SM reactor. The calorimeter probes were made of graphite for the first configuration and were made of graphite, polyethylene, aluminum, stainless steel, and lead for the second configuration. The wall temperature of the plastic irradiation capsule used in the pneumatic rabbit of the neutron activation analysis system was measured together with the temperatures in biological and steel samples and the wall temperature of a fuel assembly of WWR-SM type at the nominal power of the reactor. The measuring apparatus and the results are given in detail. (auth)

**21459** (ND-681118) STUDIES OF FFTF SURVEILLANCE, INSTRUMENTATION REQUIREMENTS. (Aerojet-General Corp.,

Sacramento, Calif. (USA)). 30 Apr 1968. 282p. Dep. NTIS $17.25.

**21460** (WANL-066) WESTINGHOUSE ASTRONUCLEAR LABORATORY PROPOSAL FOR UTILIZATION OF PLUM BROOK REACTOR FACILITY FOR THE NERVA RADIATION EFFECTS PROGRAM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Nov 1962. 18p. Dep. NTIS $4.00.

The Westinghouse proposal for additions and modifications to NASA's Plum Brook Reactor Facility to permit irradiations of NERVA materials and of NERVA subsystems and components in a physical and nuclear environment simulating operating conditions is described in detail. (LTN)

**21461** (WANL-TME-211) WESTERN NEW YORK NUCLEAR RESEARCH CENTER REACTOR PROGRAM. Kalapaca, H. P. (comp. and ed.). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 Nov 1962. 29p. Dep. NTIS $4.50.

Plans for radiation effects tests of electronic components and circuit assemblies are presented. The items are being considered for use in NERVA reactor control systems. (auth)

**21462** (WANL-TME-318) PLUM BROOK REACTOR FACILITY INPILE TEST LOOP: CONSTRUCTION AND PROCUREMENT SCHEDULES. Schlueter, J. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 24 Apr 1963. 9p. Dep. NTIS $4.00.

**21463** (WANL-TME-736) DOSIMETRY TEST EXPERIMENT RE-1 AT PLUM BROOK REACTOR FACILITY. PBRF Cycle 14 (PB No. 4W). Preliminary Data Report. Stephens, A. G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 Apr 1964. 16p. Dep. NTIS $4.00.

Thirteen dosimeter sets were irradiated in a static test to determine the spatial and energy distribution of the neutron flux density in the W-2 capsule located in HT-1 of the Plum Brook reactor. The exposure was 900 MW-hr at 125°F and average water pressure of 128 psi. Dosimetry results are given elsewhere.(LTN)

**21464** (WANL-TME-908) FINAL TEST SPECIFICATION FOR NRX-A CANDIDATE LINEAR DISPLACEMENT TRANSDUCERS TO BE IRRADIATED AT THE PLUM BROOK REACTOR (23/W205). Pappas, T. A.; Rich, R.; Rothleder, B. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Aug 1964. 12p. Dep. NTIS $4.00.

**21465** (WANL-TME-927) DOSIMETRY TEST EXPERIMENT RE-1 AT PLUM BROOK REACTOR FACILITY PBRF CYCLE 14 (PB NO. 4W). Rothleder, B. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Aug 1964. 15p. Dep. NTIS $4.00.

Dosimeters were irradiated to determine the spatial and energy distribution of the neutron flux in the W-2 Capsule located in HT-1 of the Plum Brook Reactor. Based on these results the highest epithermal and fast fluxes do not occur at the core center line. By locating samples about one foot from the center line, they may be subjected to fast and epithermal fluxes higher by a factor of six with a 30 percent decrease in thermal flux. However, these results should be verified and, if possible, related to the HT-1, W-2 geometry, by further measurements, before such action is taken. (LTW)

**21466** (WANL-TME-1343) ACTIVATION PLAN FOR THE W-1 LOOP. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Dec 1965. 20p. Dep. NTIS $4.00.

The work program and schedule required to activate the W-1 loop in the Plum Brook reactor is detailed with the expectation of irradiation at cryogenic conditions by December, 1966. (LTN)

**21467** (WANL-TME-1728) DESIGN MANUAL AND SAFETY ANALYSIS FOR EXPERIMENT 37/W407, SHIELD MATERIAL TEST. Burwell, D. L.; Brown, R. K. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1967. 12p. Dep. NTIS $4.00.

The purpose of this experiment is to obtain mechanical and physical properties data and hydrogen loss characteristics for a shield material exposed to a radiation environment. These data are required for the NERVA reactor design activities. A special safety analysis was required because of the expected temperature rise, expected activation and to ensure that the effects on reactivity were within limits. (auth)

**21468** (WANL-TNR-084) PRELIMINARY HAZARDS SUMMARY FOR NERVA IRRADIATION TESTING AT PLUM BROOK REACTOR FACILITY. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1963. 42p. Dep. NTIS $5.25.

**21469** (WANL-TNR-118(Rev.A)) OPERATION MANUAL PLUM BROOK REACTOR FACILITY EXPERIMENT NO. 63-65. Freas, D.; Geisler, G.; Quinn, J.; Thomas, P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1964. 63p. Dep. NTIS $6.25.

**21470** (WANL-TNR-119(Rev.1)) EXPERIMENT DESIGN MANUAL AND HAZARDS ANALYSIS PLUM BROOK REACTOR FACILITY EXPERIMENT NO. 63-05. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1964. 231p. Dep. NTIS $14.75.

The basic purpose of the experimental system described is to provide information which will assist in the selection of materials and components for incorporation in the NRX (NERVA Reactor Experiment) currently being designed. A water-cooled capsule has been designed and installed in HT-1 at PBRF for testing the required items in a high radiation environment. This is a loop-type facility which provides the capability for test-instrument actuation and data acquisition. The items to be tested are contained in the water-cooled capsule. Some types of test assemblies to be irradiated are pressure transducers, strain gages, linear displacement transducers, resistance thermometers, accelerometers, and various mechanical components. (auth)

**21471** (WANL-TNR-126) DESIGN MANUAL AND HAZARDS ANALYSIS FOR EXPERIMENT NO. 23/W202, LINEAR DISPLACEMENT TRANSDUCERS AT PLUM BROOK REACTOR FACILITY (RF1, 63-05). Newby, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Dec 1963. 9p. Dep. NTIS $4.00.

Experiment No. 23/W202 involves the irradiation testing of eight linear displacement transducers under the environmental conditions in the W-2 Loop of the HT-1 in the Plum Brook Reactor Facility. The hydraulic system described in WANL-TNR-119 remains the same and hazards are, in most cases, is then described in that report. Expected activations are calculated. (auth)

**21472** (WANL-TNR-141) DESIGN AND HAZARDS ANALYSIS FOR CAPSULE THERMOCOUPLES AT PLUM BROOK REACTOR FACILITY (RF1, 63-05). Newby, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Dec 1963. 7p. Dep. NTIS $4.00.

The hazards evaluation (WANL-TNR-119) presented for the W-2 loop installed at PBRF was approved by the Safeguards Committee with reservations regarding the "fail safe" features of the capsule flow instruments. To provide a secondary protection, it was ruled that the capsule wall temperature be monitored with high temperature to cause reactor scram. Subsequent operation of the W-2 loop has resulted in the failure of the capsule wall thermocouples. It is the purpose of this report to show that the same degree of safety can be achieved by monitoring and scramming from sample temperatures. (auth

**21473** REMOVAL-DIFFUSION METHODS APPLIED TO ACTUAL PROBLEMS IN REACTOR SHIELDINGS. Herrnberger, V. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen, Switzerland); Tai, A. S.; Zuber, J. F. pp 1009-1025 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]). (In French).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The computer programmes MAC-RAD and SABINE, based on the removal-diffusion methods were applied to the lay out of an inner shield of given thickness and two components (iron/moderator) with regard to various dose rates by changing the type, the content and the distribution of moderator (C, $B_4C$, $O_2O$, $H_2O$, TiH, ZrH), and to the calculation of the dose rates about the biological shield of a critical assembly for the purpose of comparing the two methods and verifying available measurements. (FR)

**21474** COMPARISON OF ONE AND TWO DIMENSIONAL DISCRETE ORDINATE CALCULATIONS WITH EXPERIMENTAL RESULTS. Fuse, T.; Yamaji, A.; Miura, T. (Ship Research Inst., Tokai, Japan). pp 1459-1471 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

Neutron transport studies in a water medium and in a cylindrical air duct in a water medium were performed. The calculations were carried out with neutron transport codes ANISN and PALLAS-SP for one dimensional spherical geometry, and also with PALLAS-CY program for two dimensional geometry. The experiments were performed in a water shield of a pool type reactor JRR-4. Measurements were made by activation method. The calculated results were converted to the reaction

rates to compare with the experimental results of absolute values. The agreement between the calculation and experiment appears to be fair. (FR)

**21475** THREE-DIMENSIONAL ANALYSIS OF THE FTR SHIELD MOCK-UP EXPERIMENT. Boulette, E. T.; Bunch, W. L.; Marr, D. R. (Hanford Engineering Development Lab., Richland, WA). pp 1131-1147 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

Diffusion theory analyses of the Fast Test Reactor (FTR) Engineering Mock-Up Critical experiments demonstrate that diffusion theory is adequate for calculating the neutron flux distribution in a fast reactor environment. The analyses also indicate that no significant neutron streaming can be associated with the FTR below-core shield. In addition to these results, the overall FTR shielding experimental program is discussed. (FR)

**21476** SUBCRITICAL REACTIVITY AS DETERMINED FROM REACTOR NOISE. Wang, H. K.; Ruby, L. (Univ. of California, Berkeley). Nucl. Sci. Eng.; 56: No. 2, 211-212(Feb 1975).

Data obtained with the Berkeley TRIGA Mark III Reactor are analyzed. A two-delayed-group approximation was found necessary to fit parameters in the expression for the variance-to-mean ratio of the neutron counting distribution. Results were found to be in good agreement with those from control rod calibrations. (auth)

**21477** CNEN ACTIVITIES 1973. Com. Naz. Energ. Nucl., Notiz.; 20: No. 11, 29-48(Nov 1974). (In Italian).

# Production and Materials Testing and Processing Reactors

*Refer also to abstracts 21400 and 21445.*

**21478** (JUL-1077) NUCLEAR DISTRICT-HEATING AND NUCLEAR LONG-DISTANCE ENERGY. Bohn, T.; Dietrich, G.; Kugeler, K.; Kugeler, M.; Niessen, H. F.; Schlenker, H. V. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Systemforschung und Technologische Entwicklung; Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung; Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Projekt Hochtemperaturreaktor mit Heliumturbinen). Jun 1974. 59p. (In German). INIS.

25 figs.; 6 tabs.; 12 refs.

A first survey is given on the possibilities of nuclear energy for heat supply of households and industry. Because the first steps are made in this field, the costs and quantities given are only a first rough estimate. Nevertheless, the results permit the conclusion that nuclear energy will have economical advantages in comparison with conventional systems for district-heating, as well as with regard to ensuring power supply in the future and economizing on energy resources. There is no difference to be found between "Nuclear District-Heating" and "Nuclear Long-Distance Energy". "Nuclear District-Heating" is a contribution to reduce pollution of the environment by using waste heat of electricity producing processes, just as "Nuclear Long-Distance Energy" contributes to this end by decentralized electricity production. (GE)

**21479** (ORNL-TM-4808) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JULY, AUGUST, AND SEPTEMBER OF 1974. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 19p. Dep. NTIS $4.00.

Reactor operation was routine this quarter with an on-stream time of 92.9% which brought the on-stream time for the year up to 86.2%. The semiannual reactor component inspection was completed and the control plates were changed. A scheduled re-examination of the cracked permanent beryllium reflector was conducted. An examination of the areas at each end of the circumferential crack on the inside surface of the beryllium did not detect any extension of this crack. One of the cracks on the outside surface has propagated from its original position near the groove for experimental facility EF-1 to the hole for beam tube HB-4. A new, small crack was also found in this area. (auth)

# Propulsion and Package Reactors

*Refer also to abstracts 19465–19471, 19762–19768, 19770–19789, 19792–19807, 20171–20174, 20176, 20181–20183, 20185, 20193–20197, 20251, 20258–20265, 20296–20301, 20339, 20340, 20342–20345, 20431, 20441–20451, 20478, 20487, 20488, 20553, 21464, 21466, 21470, 21787, 21813, 21850, and 21916.*

**21480** (AGC-2224(App.B)) PROGRAM COST REDUCTION FOR HIGH RISK DEVELOPMENT. Appendix B. (Aerojet-General Corp., Azusa, Calif. (USA)). 1964. 11p. Dep. NTIS $4.00.

Neither Aerojet nor Westinghouse subscribes to a high risk approach to a major program of the importance of NERVA. However, should such a course be followed, a significant cost reduction could be achieved by adjusting the program as recommended. Possible cost reductions are mainly characterized by eliminating major development areas which contribute significantly to the confidence level that engine hardware will perform satisfactorily or ensure that adequate backup approaches will be available, should major difficulties develop. (auth)

**21481** (AGC-2258) AEROJET-GENERAL CORPORATION RELIABILITY HANDBOOK. Volume I. Concepts. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA)). Apr 1962. 174p. Dep. NTIS $11.75.

The Aerojet-General Corporation Reliability Handbook is issued in two volumes: Volume I–Concepts, and Volume II–Reliability Methods. This handbook has been prepared for the purpose of providing uniform concepts, methods, and standards of performance that will serve as guidelines in the formulation and implementation of reliability problems for all plants, divisions, projects, and subcontractors of the Aerojet-General Corporation. Moreover, this handbook is intended to conform with all relevant military specifications and major customer requirements for reliability and sound contractual performance. Revisions of the Reliability Handbook will be issued when required or as improved concepts and methodology are developed. (auth)

**21482** (AGC-2272) REACTOR FACILITY SURVEY. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA); Aerojet-General Corp., Sacramento, Calif. (USA)). 2 May 1962. 60p. Dep NTIS $6.00.

Nine test reactors are reviewed for the purpose of establishing the feasibility of performing radiation effects testing at these facilities. The descriptions of the reactors indicate that all named are suited to assist in the solution of various problems found in the NERVA engine. (auth)

**21483** (AGC-2410(Vol. 1)) OVERALL PRELIMINARY DESIGN PACKAGE. Volume I. Instrumentation and Control System: Test Cell ETS-1, NRDS. (Aerojet-General Corp., Azusa, Calif. (USA)). Nov 1962. 509p. Dep. NTIS $28.50.

Current preliminary design information has been prepared for the Instrumentation and Control System for the Engine Test Stand No. 1 at NRDS. The data presented are for use by subcontractors in the preparation of the final detailed design for ETS-1. This preliminary design information is also to be used to establish correlation between systems and their integration into the complete site. (auth)

**21484** (AGC-2410(Vol.2)) OVERALL PRELIMINARY DESIGN PACKAGE. Volume II. Instrumentation and Control System. (Aerojet-General Corp., Azusa, Calif. (USA)). Nov 1962. 123p. Dep. NTIS $9.25.

Preliminary plans for the instrumentation and control system of a NERVA Engine Test Stand (ETS-1) are provided. (LTN)

**21485** (AGC-2427(Vol.2)) PRELIMINARY DESIGN REPORT NERVA EXHAUST DUCT, ETS-1 AGC-2 LARGE RADIUS ELBOW. Volume II. (Aerojet-General Corp., Azusa, Calif. (USA)). Aug 1963. 275p. Dep. NTIS $16.75.

The purpose of the secondary gas generator system is to provide the gas required by the ejector nozzle located in the bent-tube eductor for the safe disposal of hydrogen propellant in altitude simulation operations. At full-flow operation of the NERVA engine, the hot exhaust gas passing through the eductor is sufficient to maintain the vacuum. Unlike the usual chemical rocket, however, the startup and shutdown transients for the nuclear rocket are sufficiently long that an external or secondary gas source must be used during these transient periods. For operational safety during the lengthy cooling portion of the NERVA engine test duty cycle, it is desirable to have the secondary gas source available for instant use if a malfunction should occur. NERVA engine hot exhaust gas is pure hydrogen traveling at a very high velocity. To be useful in providing the required aspirating action, the secondary gas must have an exit velocity from the ejector nozzle which at least approaches the hyrogen velocity. Of the many pertinent variables, the two most important are molecular weight and temperature. The secondary gas finally chosen was a hydrogen-rich mixture formed from the combustion of liquid hydrogen with just enough liquid oxygen to heat the resulting gas. It was established that the ratio of absolute temperature

to molecular weight for this gas (a measure of acoustic velocity) must have a minimum value of 465°R lb-mol/lb for adequate system performance. The system must be very reliable to eliminate the possibility of hydrogen explosions. A preliminary design is presented. (auth)

**21486** (AGC-2469(Rev.B)) RELIABILITY AND QUALITY ASSURANCE PROGRAM PLAN FOR NERVA ENGINE SYSTEM. Revision B. (Aerojet-General Corp., Sacramento, Calif. (USA)). 30 Jan 1966. 141p. Dep. NTIS $10.25.

Aerojet and the major subcontractor plants participating in the NERVA Program shall maintain an effective and timely Reliability and Quality Assurance (R&QA) Program, planned and developed in conjunction with all other functions necessary to satisfy the SNP-1 contract requirements. The program shall ensure that contract requirements are satisfied throughout all phases of contract performance, including: design, development, fabrication, processing, assembly, inspection, test, checkout, packaging, shipping, storage, maintenance, test preparation, test operation, and test analysis. The program shall provide for the early and prompt detection of actual or potential deficiencies, system incompatibility, marginal quality, and trends or conditions which could result in unsatisfactory quality. It shall also provide timely and effective corrective action of all such conditions. (auth)

**21487** (AGC-2469(Rev.C)) RELIABILITY AND QUALITY ASSURANCE PROGRAM PLAN FOR NERVA ENGINE SYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1966. 118p. Dep. NTIS $9.00.

Aerojet and the major subcontractor plants participating in the NERVA program will maintain an effective and timely reliability and quality assurance program, planned and developed in conjunction with all other functions necessary to satisfy the SNP-1 contract for the technology and NERVA engine programs. The program will ensure that contractual reliability and quality requirements are satisfied throughout all phases of contract performance, including design, development, fabrication, processing, assembly, inspection, test, checkout, packaging, shipping, storage, maintenance, test preparation, test operations, and test analysis. The program will provide for the early and prompt detection of actual or potential deficiencies, system incompatibility, marginal quality and trends or conditions which could result in unsatisfactory quality or reliability performance. It will also provide timely and effective correction action of all such conditions. (auth)

**21488** (AGC-2493) SCALE-MODEL HEAT-TRANSFER TESTS OF THE NERVA NOZZLE CY1962. (Aerojet-General Corp., Azusa, Calif. (USA)). Apr 1963. 105p. Dep. NTIS $8.25.

Declassified [1974].

A test program was conducted to obtain experimental data on local heat-transfer rates to the NERVA hot-gas bleed port, and to a conical nozzle. Measurements were made by determining the transient behavior of a thermally thin wall. The test data for both the nozzle and bleed port areas were then correlated in terms of Nusselt, Stanton, and Reynolds numbers. (auth)

**21489** (AGC-2641) PRELIMINARY TEST REPORTS FOR GROUND TEST REACTOR (GTR). (Aerojet- General Corp., Azusa, Calif. (USA)). May 1963. 56p. Dep. NTIS $6.00.

**21490** (AGC-2678) ETS-1, NES PERFORMANCE AND DESIGN CRITERIA. (Aerojet-General Corp., Azusa, Calif. (USA)). Sep 1963. 92p. Dep. NTIS $7.75.

The test results of the ejector scale model test program are presented as they apply to the full scale Engine Test Stand-1 (ETS-1). The purpose of this evaluation was to determine the performance and design criteria for subsonic turn ejector systems in the NERVA Exhaust System (NES) for the ETS-1. The experimental tests were conducted on $\frac{1}{4}$ scale models. The analytical and experimental results, and the evaluation of the sub-scale model tests, are presented in REON Report No. 2679. As a result of the data obtained and the analytical evaluation, the design implications for the NES for ETS-1 have been drawn. (auth)

**21491** (AGC-2726) RADIATION EFFECTS PROGRAM PLANNING DETAILS FOR GENERAL DYNAMICS, FORT WORTH FOR CONTRACT YEAR 1964. (Aerojet-General Corp., Azusa, Calif. (USA)). Nov 1963. 28p. Dep. NTIS $4.50.

Final planning details are presented for the Radiation Effects Program to be conducted at the Reactor Facilities operated by General Dynamics/Fort Worth at Fort Worth, Texas, for Contract Year 1964. Detailed descriptions of work to be performed will be furnished as applicable in individual test specifications for the various components. This work will be conducted under the supervision of REON, and represents the combined efforts of REON; Westinghouse Astronuclear Laboratory; Bendix Products Aerospace Division; AMF Atomics, a division of American Machine and Foundry Co.; and the Liquid Rocket Plant of Aerojet-General Corporation. (auth)

**21492** (AGC-4510-1035) NERVA RELIABILITY METHODS AND PROCEDURES. Volume IIIB. Advanced Probabilistic Design, 600 Series. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA)). Feb 1971. 254p. Dep. NTIS $15.75.

In the 600 series of reports, the basic statistical methodology is provided. A compendium of statistical distributions is listed with properties, tables, and instructions for use. The validity and consequences of assuming normality are discussed. A method of analyzing test data to estimate failure rates when the true reliability is not constant is developed. The use of random number generators in the Monte Carlo process for computer simulation is explained. The treatment is advanced, and with specific instructions, examples, computer programs, etc. (LTN)

**21493** (AGC-8207-63-14) STRUCTURAL DEVELOPMENT TEST PLAN. NERVA Aluminum Pressure Vessel S/N 0000003. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 26 Sep 1963. 14p. Dep. NTIS $4.00.

The structural testing and associated structural analysis for NERVA aluminum development pressure vessel S/N 0000003 are defined. The main purpose is to determine pressure vessel forward closure bolted joint and nozzle bolted joint behavior when subjected to a one zone pressurization. In addition, the displacement of control drum ports will be measured to supplement data acquired in the previously completed hydrostatic test of pressure vessel S/N 0000002. The primary objectives are: To provide necessary data for pressure vessel joint deflections and rotations when the pressure vessel is subjected to a one zone pressurization; to provide necessary data for correlation of analytical and experimental results; and to provide information on pressure vessel control drum deflections for reactor assembly interface analysis. (auth)

**21494** (AGC-8207-63-25) DEVELOPMENT OF A NERVA TITANIUM PRESSURE VESSEL. (Aerojet-General Corp., Sacramento, Calif. (USA)). 20 Dec 1963. 75p. Dep. NTIS $6.75.

A titanium pressure vessel for NERVA engine use has been successfully designed, fabricated, and hydrostatically tested. Since the working fluid of the NERVA engine is liquid hydrogen, the pressure vessel had to be made from a minimum weight material which could withstand the temperatures and pressures required in the engine system. In addition, the material selected would be required to exhibit a minimum degradation of properties in a nuclear radiation environment. Good low temperature ductility and toughness properties combined with a good strength to weight ratio led to the selection of the extra low interstitial (ELI) grade of A110-AT (5Al-2.5Sn) titanium for this application. Design layouts of the required geometry, supported with stress analysis, resulted in the configuration fabricated. (auth)

**21495** (AGC-8207-64-2) TEST PLAN FOR CRYOGENIC METALLIC SEALS TESTS. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 30 Mar 1964. 17p. Dep. NTIS $4.00.

Plans for cryogenic testing of metallic seals designed for use in NERVA pressure vessel joints are described. The tests will be conducted using a test vessel with internal volume displacement to maintain minimum gas energy. The tests will serve as a means of evaluating leakage for comparison with the maximum permissible leakage of $10^{-2}$ standard cubic centimeters per second per inch of diameter. The tests will be performed at ambient and at minus 300 ± 20°F using a helium and a hydrogen testing medium. (auth)

**21496** (AGC-8207-64-4) NERVA THRUST STRUCTURE S/N 001. Resonance Survey Evaluation Report. Rosser, R. C.; Cornell, A. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 13 Apr 1964. 95p. Dep. NTIS $7.75.

The dynamic test of the NERVA Thrust Structure, S/N 001 – NERVA Thrust Structure Resonance Survey, was performed in September 1963. The test was successful in (1) determination of the first principal transverse natural frequency of approximately 44 cps, (2) definition of its associated mode shape, (3) determination of the second principal transverse natural frequency of approximately 178 cps, (4) definition of its associated mode shape, and (5) providing information on the elasticity of the gimbal joint and of the dummy gimbal actuation system. Analytical analysis correlated the above findings. (auth)

**21497** (AGC-8207-64-5) TEST PLAN AND SPECIFICATIONS FOR THE PRESSURE VESSEL-NOZZLE-SEAL ASSEMBLY CONFIRMATION TEST. Test 1070 N. Smith, L. M.; Cornell, A. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 5 May 1964. 28p. Dep. NTIS $4.50.

Pressure vessel-nozzle-seal assembly confirmation tests are described. They involve hydrostatic pressure testing and evalua-

tion of the seals. The purpose is to demonstrate the compatibility of two possible NRX nozzles (AGC-347 stainless steel nozzle S/N 008, P/N 285950-9 and Rocketdyne-Inconel X RN-6 stubby nozzle, P/N 99205795) with NRX 6061-T6 aluminum pressure vessel, S/N 005. These tests will prove the structural integrity of the nozzles for use in NRX test programs with the functional capability to be demonstrated by acceptance chemical firings. In addition, a seal evaluation will be performed using AGC 6061-T4 aluminum pressure actuated seals with the forementioned hardware. (auth)

**21498** (AGC-8209-64-5) OPERATIONAL AND TECHNICAL DISCUSSION OF NOZZLE TUBE PROGRAM. Uffer, R. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 17 Feb 1964. 20p. Dep. NTIS $4.00.

A computer program designed to analyze heat transfer and pressure drops in the NERVA nozzle tubes for a steady state point is described. As all geometric configurations are input values, the program may be used for other configurations including skirt coolant tubes. The program will check for throat choking and raise the inlet pressure to pass the input flow rate. If the nozzle is not choked, input pressure will remain the same. The program also has an option to calculate a discontinuous pressure drop after the throat. This is used in case there is choking both in the nozzle tubes and in another point downstream in the system. (auth)

**21499** (AGC-8209-64-9) OPERATIONAL DESCRIPTION OF THE NERVA ENGINE BALANCE STEADY STATE PROGRAM. Stiger, R. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). 3 Mar 1964. 29p. Dep. NTIS $4.50.

The purpose of the NERVA Engine Balance-Steady State Program is to calculate the state variables at all major points in the NERVA Engine System for a steady state operating point. The program will calculate the core power necessary to sustain a desired chamber temperature, or the chamber temperature resulting from a given core power for an inlet temperature and pressure. A parameter schedule is calculated for all components by iteratively balancing the engine system. Input is required to describe the physical characteristics of the system, i.e., turbine power control valve setting, various "K" values throughout the system, and the ratio of energy absorbed in the reflector to energy absorbed in the core. The ability to vary the physical characteristics of the system lends a greater flexibility to the program. The hot bleed port and nozzle tube sub-systems parameters are calculated by incorporating the Hot Bleed Port and Nozzle Tube Programs as subroutines in the engine balance. Consequently, input similar to that used in these programs is required as a part of the steady state program. (auth)

**21500** (AGC-8209-64-10) THERMAL ANALYSIS OF U-TUBE NOZZLE UNDER NRX-A1 COLD FLOW CONDITIONS. Thomas, E. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). 6 Mar 1964. 101p. Dep. NTIS $8.25.

The temperature distribution in the jacket of the U-tube nozzle when exposed to NRX-A1 cold flow conditions with liquid hydrogen was determined. The effect of the pressure vessel on the nozzle is negligible. Any differences in the analyses with intimate contact or infinite resistance between nozzle and pressure vessel are confined to the immediate vicinity of the interface. The chilldown is not severe enough to cause a thermal shock problem. (auth)

**21501** (AGC-8771-2251) RADIATION LEVEL BEHIND EIT-502 SHADOW SHIELD AND MATERIALS EVALUATION OF LING MODEL A280 AND B280 SHAKERS. Fluke, G. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 27 Nov 1963. 5p. Dep. NTIS $4.00.

A considerable radiation field exists behind the EIT-502 shadow shield and equipment to operate behind it should be analyzed for heat transfer rates and damage in the attenuated radiation field. It is recommended that organic components such as neoprene, silicone rubber, nylon, etc. be replaced by more radiation-resistant materials. (LTN)

**21502** (AGC-90013) DESIGN SPECIFICATION: ENGINE, ROCKET, NUCLEAR, NRX/EST. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Jan 1965. 20p. Dep. NTIS $4.00.

The NRX/EST Engine is to be specifically designed to demonstrate the feasibility of a hot-bleed cycle nuclear engine. It comprises a basic NRX-A Reactor Subsystem, NERVA Propellant Feed System, and a hot-bleed port nozzle. The engine will be installed on a NRX-A Test Car for static firing tests in Test Cell "A." Major subsystems are also specified. (auth)

**21503** (AGC-9443-63-11) TEST PLAN FOR NERVA PRESSURE VESSEL METALLIC SEALS TEST. Locke, J. N. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 May 1963. 13p. Dep. NTIS $4.00.

The plan for testing metal seals designed for use in NERVA pressure vessel joints is described. The tests will be conducted using an aluminum pressure vessel assembly and a structural test nozzle (with pressure vessel internal volume displacement to maintain minimum gas energy). The tests will serve as a means of evaluating leakage for comparison with the maximum permissible leakage of $10^{-2}$ standard cubic centimeters per second per inch of diameter. The tests will be performed at ambient temperature using a helium testing medium in a one zone pressure system. (auth)

**21504** (AGC-9548-62-7) STRUCTURAL DEVELOPMENT PROGRAM. NERVA Thrust Structure. Revision B. Thomas, R. W.; Cornell, A. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 3 June 1963. 20p. Dep. NTIS $4.00.

The structural testing and associated structural analysis of the initial NERVA upper and lower thrust structures are planned. Axial and lateral accelerations result in axial, lateral and bending loads on both structures. The temperature and irradiation effects will be considered only in the theoretical analysis to support fabrication drawing approvals. Testing will be performed at ambient temperatures in a non-nuclear environment using static loads. The objectives of this development program are to: Demonstrate structural integrity under static test loads, determine axial and lateral stiffness of each structure, provide information on the effect of thrust structure deflections on thrust misalignment, permit a correlation of experimental and theoretical data, and provide information for design improvement. (auth)

**21505** (LA-2867) DEVELOPMENT AND FABRICATION OF [SUPPORT] FOR THE KIWI-B4A NUCLEAR PROPULSION REACTOR. Sandstrom, D. J.; Hanks, G. S. (Los Alamos Scientific Lab., N. Mex. (USA)). Jan 1963. Contract W-7405-eng-36. 83p. Dep. NTIS $7.25.

Declassified 28 Aug 1973.

A new method of core support was devised for the KIWI-B4 series of nuclear rocket engines, in which the fuel elements are hung in clusters. The supporting member is a 57 in. long, 0.125 dia, 17-7pH stainless steel tie rod headed at one end and threaded at the other end. The development and fabrication of the tie rods are discussed. (auth)

**21506** (LA-2922) RADIOCHEMICAL MEASUREMENTS ON KIWI-B1B. Wagner, G. F.; Sattizahn, J. E. (Los Alamos Scientific Lab., N. Mex. (USA)). Jun 1963. Contract W-7405-eng-36. 93p. Dep. NTIS $7.75.

Declassified 27 Aug 1973.

The techniques and results of radiochemical measurements associated with the KIWI-B1B reactor test of September 1, 1962 are described. Information is given on total fissions produced, radial and axial fission distribution, temperature distribution, and core anomalies. (auth)

**21507** (LA-3158) RADIATION HEATING RATE ESTIMATES FOR A PHOEBUS REACTOR. Watson, C. W.; Peterson, D. M. (Los Alamos Scientific Lab., N. Mex. (USA)). May 1964. Contract W-7405-eng-36. 70p. Dep. NTIS $6.75.

Declassified 28 Aug 1973.

Results of radiation heating rate calculations are presented for an operating 5000 MW Phoebus reactor. Also presented, in appendices, are computational details, auxiliary results (e.g., radiation dose rate estimates), and comparisons of the present estimates with scaled data from previous (Kiwi) radiation environmental studies. Of a total of approximately 495 MW of radiation energy generated by this core, ~351 MW are absorbed in the core itself (including support blocks), ~59.3 MW are deposited in the immediate core environs (excluding the nozzle), and about 85 MW escape from the reactor system. Although the estimates presented apply specifically to the reactor system as described, and will require revision as the Phoebus concept evolves, the heating rates given should be adequate for preliminary design purposes and, with some modification, should be applicable to a wide class of Phoebus reactors. (auth)

**21508** (LA-3323) STUDY OF POWER DENSITY AND THERMAL STRESS LIMITATIONS OF ROVER REACTOR FUEL ELEMENTS. Rowley, J. C.; Prince, W. R.; Gido, R. G. (Los Alamos Scientific Lab., N. Mex. (USA)). 28 May 1965. Contract W-7405-eng-36. 106p. Dep. NTIS $8.50.

Declassified 29 Aug 1973.

An experimental and analytical program to establish the power density thermal stress limits for Rover reactor fuel elements is described. The apparatus and experimental techniques developed, methods of analysis, and results to date are presented. (auth)

**21509** (LA-3358) SAFETY NEUTRONICS FOR ROVER REACTORS. King, L. D. P. (Los Alamos Scientific Lab., N. Mex. (USA)). 31 Oct 1965. Contract W-7405-eng-36. 222p. Dep. NTIS $14.25.

Declassified 28 Aug 1973.

The results of possible nuclear accidents with NERVA type reactors are considered in some detail. Various possibilities are considered, e.g., launch pad accidents, partial destruction, hydrogen insertion, water immersion, etc. A detailed description of the experimental Kiwi-TNT full scale excursion is presented since it forms the basis for the normalization of all these accident calculations. Some of the studies involve the release of fission products, including leaching of fuel debris by water and sea water. Reactors with locked control drums and containing poison wires are considered unlikely to cause an accident. (LTN)

**21510** (NJD-13) XE-1 OPERATING LIMITS DOCUMENT, PHASE II. (Aerojet-General Corp., Sacramento, Calif. (USA); Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Oct 1968. 18p. Dep. NTIS $4.00.

Constraints pertinent to safety and which serve as a basis for SNPO approval for XE-1 Phase II engine operations to be accomplished at the Nuclear Rocket Development Station (NRDS) are defined. The XE-1 Phase II operations encompass low, intermediate and full power tests starting with initial criticality, and including non-run periods subsequent to initial criticality, return of the engine to E-MAD following power operation, and the initial steps of engine disassembly. The operating limits contained herein specify the administrative and technical boundaries within which these Phase II engine operations will be performed. (auth)

**21511** (NJD-13(Rev.)) XE-1 OPERATING LIMITS DOCUMENT, PHASE II. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 10 Jun 1969. 13p. Dep. NTIS $4.00.

Ground level wind restrictions under which NERVA engine testing may be conducted are relaxed. The relaxation is justified on the basis of new operating experience, facility modifications, provision of gas masks (effective against radioiodine), emergency evacuation procedures, etc. (LTN)

**21512** (NJD-15) XE-2 SAFETY EVALUATION REPORT, PHASE IA. (Aerojet-General Corp., Sacramento, Calif. (USA); Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). May 1968. 16p. Dep. NTIS $4.00.

Safeguards which will prevent accidental criticality during the sequence of E-MAD assembly operations on XE-2 up to, but not including, central poison wire removal are summarized. These operations will be performed in the facilities, with the equipment, and in the manner that are essentially equivalent to those followed for XE-1. These operations include: Receiving and Inspection of the Reactor, Assembly of the Test Article and Peripheral Poison Wire Removal. The sequence of these operations is shown. Peripheral poison wire removal operations may be conducted before or after installation of the control drum actuators. In order to prevent fuel hydrolysis similar to that which occurred in the XE-1 reactor, it is planned to have the Pressure Vessel/Reactor Assembly under a continuous, high-purity gas purge during all periods of E-MAD storage, inspection and assembly operations. The administrative and technical boundaries within which the assembly operations will be performed are specified in the "XE-2 Operating Limits Document, Phase IA", NJD-16. The potential mechanisms which could lead to an accidental criticality of the XE-2 reactor subassembly in the E-MAD Assembly Area are identified. These are accidental insertion of moderation, particularly hydrogenous material after removal of the peripheral poison wires, loss of shutdown margin through excess reflection, and accidental rotation of the control drums. (auth)

**21513** (NJD-0025) SUMMARY REPORT OF WORK TO DATE ON THE NERVA DIGITAL CONTROL SYSTEM DESIGN. Porcelli, G. (Aerojet-General Corp., Sacramento, Calif. (USA)). 30 Sep 1970. 119p. Dep. NTIS $9.00.

Digital control system development efforts are summarized. Significant documentation is attached. An introductory section correlates the different documents, points out the relevant accomplishments and findings, states the present level of activity in each area, reports the results of undocumented effort, and summarizes future plans. (auth)

**21514** (NR-69053(Folder 2)) DESIGN AND FABRICATION OF PROTOTYPE PRIMARY NaK LOOP VALVE SETS. Folder 2: Business Management and Costs. (Aerojet-General Corp., Sacramento, Calif. (USA)). 24 Jun 1969. 113p. Dep. NTIS $8.75.

In answer to a request for proposals, a proposal is submitted for the design, fabrication and testing of primary NaK Loop (PNL) valves for use in ground testing of the SNAP-8 power conversion system. Most of the long proposal describes the company's development experience and technical expertise in liquid metals, facilities, personnel, management, etc. and discusses the valves only to question whether the pressure differential is adequate for self activation, to suggest alternative activation possibilities and to estimate a cost of the design work. (LTN)

**21515** (NTO-R-0028) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IV. Full Power Test. NRX-A3 Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 28 Apr 1965. 80p. Dep. NTIS $7.00.

Experimental Plan-IV of the NRX-A3 Test Series was completed on April 23, 1965 at Test Cell "A" facilities. Particular requirements of the NRX-A3 Test Specification, WANL-TNR-161, pertaining to operation at full power were partially satisfied. A system abnormality caused abortion of the test prior to achieving all of the prime objectives. Prior to shutdown the test assembly had operated for a total of about eight minutes at power, the last 3.5 minutes at full power. A review of the data during the normal full power hold, and during the startup holds, indicates that reactor temperatures, pressures, and pressure drops agreed very well with predictions. Other data, such as strains and accelerations, indicate there was no damage to the reactor assembly during the full power run. (auth)

**21516** (NTO-R-0029) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IIIA. Flow Tests and Scaled Down Power Tests. NRX-A3 Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 18 May 1965. 74p. Dep. NTIS $6.75.

Experimental Plan-III-A of the NRX-A3 Test Series was completed on May 13, 1965, at Test Cell "A" facilities. Particular requirements pertaining to both gaseous and liquid hydrogen flow testing and scaled-down power testing were successfully satisfied. From the results and from a comparison with previous EP's, it can be concluded that there is no detectable change in the continuity of the flow passages in the nozzle and reactor. In addition, there is no evidence to indicate any structural defects in the nozzle. The test objectives were successfully completed and no abnormalities were noted. (auth)

**21517** (NTO-R-0030) NRX-A3 PRE-TEST REPORT. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 24 May 1965. 73p. Dep. NTIS $6.75.

The pretest inspection and assembly of NRX-A3, poison wire removal and control drum checkout are described. The detailed procedures were followed and the work accomplished without major problems. The assembly was completed March 5, 1965. It was transferred to test cell "A" and, after pretest operations, were completed the first experimental plan was carried out April 7, 1965. (LTN)

**21518** (NTO-R-0031) THREE-DAY REPORT FOR EXPERIMENTAL PLAN V. Restart Full Power Test. NRX-A3 Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 25 May 1965. 98p. Dep. NTIS $8.00.

Experimental Plan V of the NRX-A3 Test Series was completed on May 20, 1965 at Test Cell "A" facilities. Particular requirements of the NRX-A3 Test Specification, WANL-TNR-161, pertaining to operation at full power were satisfied. The Test was shutdown upon reaching an indication of the preselected low-level capacity for dewar "C". Prior to shutdown the test assembly had operated for approximately 16 minutes at power, of which 13.1 minutes were at full power. During conduct of the test, no major difficulties were encountered. A review of test data indicates that all components functioned in accordance with design predictions; that there is no evidence of gross damage to any component; and that data compared very favorably with steady-state data obtained during the full-power run of EP-IV. Although radiation environment studies indicate fuel losses to be greater than during EP-IV, losses appear to be normal. Observations during the test did not detect any gross ejection of debris from the nozzle, and control drum withdrawal during the full-power hold was at a fairly constant rate. The post-test critical drum position agreed with predictions within the limits of experimental accuracy. The combination of EP-IV and V gives an integrated operating time at power of approximately 26 minutes, of which 16.5 minutes were at full power. Prior to beginning this run, anomalies reported from EP-IV but still outstanding after EP-IIIA, were satisfactorily completed. (auth)

**21519** (NTO-R-0036) NRX-A3 SITE TEST REPORT. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 2 Jul 1965. 299p. Dep. NTIS $18.00.

The NRX-A3 Test Series was conducted at Test Cell "A" facilities between April 7 and May 28, 1965. Anomalous behavior during Experimental Plan IV resulted in exceeding design temperature limits of some system components, but no apparent damage occurred which would prevent further full-power testing. In general, performance of the reactor was in accordance with predictions. Reactor parameters such as temperatures, temperature distribution, pressures, and pressure drops agreed very well with predictions and were reproducible from one test to another. During the conduct of the test series numerous system anomalies occurred. Most of these did not seriously affect the

conduct of the test since either a temporary correction was possible or the anomaly was not serious enough to preclude operation or continuing operations. All anomalies were investigated and the necessary corrective action taken to preclude recurrence during succeeding tests. (auth)

**21520** (NTO-R-0050) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IA. Initial Criticality and Control Drum Measurements. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 15 Dec 1965. 54p. Dep. NTIS $5.75.

Experimental Plan IA was performed on December 8, 1965 at the Test Cell "A" facilities. Particular requirements of the NRX/EST Test Specification, NJD-2, pertaining to initial criticality and control drum worth measurements were satisfied. Significant operations included removing the central poison wires, attaining initial criticality, and obtaining control drum bank worth measurements. The cold flow tests originally planned for EP-IA were not performed due to insufficient control room time. Some problems which caused some concern during the initial central poison wire removal operation are discussed. (auth)

**21521** (NTO-R-0051) THREE DAY REPORT FOR EXPERIMENTAL PLAN IA PRIME. PCV-41 Pressure Loop Checkout and Initial Cold Flow Tests. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 20 Dec 1965. 67p. Dep. NTIS $6.25.

Experimental Plan IA Prime was performed on December 15, 1965 at the Test Cell "A" facilities. Particular requirements of the NRX/EST Test Specification, NJD-2, pertaining to the checkout of the PCV-41 Pressure Control Loop were satisfied. Significant operations included: frequency response measurements on the PCV-41 Pressure Controller and four cold flow tests. The PCV-41 Pressure Control Loop was found to be stable and the checkout was satisfactory. Control drum behavior and system pressure observed during the ambient hydrogen gas runs were as predicted. The four cold flow tests were not successful in that the turbine failed to rotate as predicted. Upon post-test examination it was found that the turbine exhaust lines showed evidence of overheating. This led to the conclusion that hydrogen burning occurred intermittently in one or the other of the turbine exhaust stacks. Preliminary investigations revealed no damage or abnormalities in the turbine. (auth)

**21522** (NTO-R-0052) NRX/EST PRE-TEST REPORT. Final Issue. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 30 Dec 1965. 63p. Dep. NTIS $6.25.

The NRX/EST assembly operations phase began in June with the installation of the Flow Straightener on to the NRX/EST Test Car (T-2) and was completed with the installation of the Privy Roof Mount Shield. The Test Assembly was transferred to Test Cell "A" on October 18, 1965. The Test Cell/Test Car Mate-up and final pre-test preparations were completed by December 4, 1965. In general, the assembly work at the R-MAD Building and the mate-up and pre-test preparations work at Test Cell "A" was accomplished as planned without any major problems. (auth)

**21523** (NTO-R-0054) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IA DOUBLE PRIME. Initial Cold Flow Bootstrap. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 11 Jan 1966. 60p. Dep. NTIS $6.00.

Experimental Plan IA Double Prime of the NRX-A4-EST Series was performed on Janurary 6, 1966 at the Test Cell "A" facilities. Significant operations included: (1) response measurements were made on the power control loop, (2) the turbopump assembly did rotate, and (3) the Test Assembly did bootstrap. Certain anomalies and value problems are discussed. (auth)

**21524** (NTO-R-0057) THREE DAY REPORT FOR EXPERIMENTAL PLAN IA-4: COLD FLOW TESTS. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 15 Jan 1966. 59p. Dep. NTIS $6.00.

Experimental Plan IA-4 of the NRX-A4-EST Test Series was performed on January 19, 1966 at the Test Cell "A" facilities. Five cold flow tests were performed at various dewar pressures and chamber demand pressures. All of the tests were successful. With the exception of the first test, all test results confirmed predictions based on CFDTS and analog data. The test cell wall heat shield adequately protected the test cell wall and components, however, it was damaged in the process and is being re-designed. (auth)

**21525** (NTO-R-0058) THREE DAY REPORT FOR EXPERIMENTAL PLAN IB PRIME. Neutronics Calibration, Control Drum Worth Measurements and Low Power Dosimetry. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 26 Jan 1966. 55p. Dep. NTIS $5.75.

Experimental Plan IB Prime of the NRX-A4-EST Series was performed on January 21, 1966, at Test Cell "A" facilities. Requirements of the NRX/EST Test Specification, NJD-2, pertaining to the Neutronics Calibration, Control Drum Worth Measurements and Low Power Dosimetry were satisfied. Significant operations were: Activation of calibration wires, determination of the integral worth of drums 2 and 9 by both the reactivity meter and period measurement method, determination of the integral worth of each control drum by use of the reactivity meter, and irradiation of low power dosimetry. All tests were successfully completed and the major test objectives achieved. No system abnormalities were noted. Determination of drum worths utilizing the reactivity meter were in good agreement with those obtained by period measurement. Preliminary analysis indicates that all control drums have essentially the same worth. (auth)

**21526** (NTO-R-0059) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IIA AND IIB. Neutronics Rams Set, Scaled Down Power Test, and Intermediate Power Bootstrap Tests. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 9 Feb 1966. 94p. Dep. NTIS $7.75.

Experimental Plan IIA was performed on February 2, 1966 at the Test Cell "A" facilities. Significant operations included: Phase II Neutronic Calibration, and Scaled Down Bootstrap Test to intermediate power. The reactor was operated at a power level of 0.001 of that planned for the actual test with all other parameters simulated. Additional radiation level measurements were taken in the DCS Enclosure during the test. The Test Assembly and test facilities operated as expected and no significant anomalies were noted. Experimental Plan IIB was performed on February 3, 1966. The test consisted of two bootstrap startups to intermediate power. After this test a scram was initiated but control drum one did not scram but remained at a nominal 90° position for approximately 200 seconds. The anomalous behavior of control drum #1 is being investigated. Preliminary evaluation indicates the problem may be associated with a "freeze-up" caused by liquid nitrogen dripping onto the hydraulic line. (auth)

**21527** (NTO-R-0060) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IIC: INTERMEDIATE POWER BOOTSTRAP AND CONTROLS TEST. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 17 Feb 1966. 77p. Dep. NTIS $7.00.

Experimental Plan IIC of the NRX-A4-EST Test Series was performed on February 11, 1966 at the Test Cell "A" facilities. Significant operations included: Bootstrap startup to intermediate power with constant drum position; system response measurements; limiter checkout; checkout of no flux loop temperature controller; and mapping a constant chamber temperature line of the operating map. The first bootstrap startup was with constant drum positions to a chamber temperature of 2000°R. At this hold point response measurements were obtained on the system. Chamber temperature was then programmed down to 1700°R, at which time the planned manual flow shutdown was performed. Post-test evaluation of the data indicates that the fixed drum startup was very successful. The second bootstrap was to be performed at a dewar pressure of 35 psia, but system chilldown problems at this low dewar pressure precluded carrying out this startup. The dewar pressure was then increased to 45 psia to attempt to correct the chilldown problem and bootstrap startup attempted even though a complete chilldown was not attained. This startup was terminated prior to reaching the first hold point of 2000°R by a manual flow shutdown when the tie rod exit gas temperature increased rapidly to 1050°R. It appears that the incomplete chilldown caused the bootstrap flow rate to lag the programmed power thereby causing the tie rod exit gas temperatures to approach the test parameter limit. (auth)

**21528** (NTO-R-0063) THREE-DAY REPORT FOR EXPERIMENTAL PLAN III. Full Power and Engine Mapping Test. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 9 Mar 1966. 67p. Dep. NTIS $6.50.

Experimental Plan III of the NRX-A4-EST Series was performed on March 3, 1966, at the Test Cell "A" facilities. Significant operations included: Bootstrap to full power, and mapping of the engine operating map. The pre-operational phases of the tests were carried out with only minor problems. Performance of all facility systems were as expected with no major abnormalities experienced. There was insignificant reactivity loss during EP-III. (auth)

**21529** (NTO-R-0066) THREE-DAY REPORT FOR EXPERIMENTAL PLAN IV: ENGINE DURATION TEST. NRX/EST Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 22 Mar 1966. 65p. Dep. NTIS $6.25.

Experimental Plan IV of the NRX-A4-EST Series was performed

on March 16, 1966, at the Test Cell "A" facilities. Significant operations included bootstrap to 2000°R Tc with fixed drums at a dewar pressure of 45 psia, response measurements on the TPCV control loop and drum position control loop at 4000°R Tc, mapping of 4000°R Tc line from Pc of 540 psia down to 250 psia, and approximately 14.8 minutes at nominal rated chamber temperature conditions. After performing the pre-operational phase with no significant anomalies being observed, the low dewar pressure startup was attempted. When it failed, the bootstrap startup was then successfully carried out at a dewar pressure of 45 psia. During the cooldown operation after the run, PCV-41 became inoperative in that the valve would not close. Post-test inspection showed that the valve was in the full open position and that the valve feedback pot had come loose. (auth)

**21530** (NTO-R-0070 and (Add.1)) NRX/EST DOSIMETRY DATA REPORT. Seibold, J. R. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 1 Sep 1966. 23p. Dep. NTIS $4.25.

Several kinds of dosimeters were exposed in the NRX-A4-EST Test at various locations (which are listed). Measurements made at low, intermediate and high reactor power are reported. In addition, selected external power calibration wire results and pad/scatter experiment results are reported. (LTN)

**21531** (NTO-R-0075) NRX-A5 PRE-TEST REPORT. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 26 May 1966. 59p. Dep. NTIS $6.00.

The NRX-A5 assembly operations phase began 23 March 1966 and transfer of the Test Car/Test Assembly to Test Cell "A" was completed on April 19. The normal assembly operations included receipt, inspection, checkout, and installation or assembly of all reactor components, coolant systems and instrumentation. Poison wire removal was also a normal part of the assembly operation. All of these efforts were performed as planned with little or no deviation from the expected. Problem areas, as they arose, were disposed of in accordance with established procedures. The assembly effort, in general, proceeded smoothly. (auth)

**21532** (NTO-R-0076) TEST REPORT FOR EXPERIMENTAL PLAN I. NRX-A5 Test Series. Initial Criticality, Neutronics Calibration, Control Drum Worth Measurements, and Flow Tests. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 2 Jun 1966. 74p. Dep. NTIS $6.75.

Experimental Plan I of the NRX-A5 Test Series was performed on May 26, 1966, at the Test Cell "A" facilities. Significant operations included: initial criticality, phase I neutronics calibration, control drum worth measurements, response measurements on the power controller, ambient $GH_2$ flow test, response measurements on PCV-41 pressure controller, cold $GN_2$ flow test, and scram $LH_2$ flow decay tests. Three types of drum worth measurements were performed: integral worth of drum number 2, relative integral worth of each of the drums, and banked differential worth near the critical drum position. Preliminary evaluation of these measurements indicated the drum worth agreed with the predictions and that the worths of the individual drums were essentially the same. (auth)

**21533** (NTO-R-0078) TEST REPORT FOR EXPERIMENTAL PLANS II AND III. NRX-A5 Test Series. First Power Test. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 14 Jun 1966. 79p. Dep. NTIS $7.00.

Experimental Plans II and III of the NRX-A5 Test Series were successfully performed on June 8, 1966, at the Test Cell "A" Facilities. Significant operations of EP-II included: Phase II Neutronic Calibration, Power Limiter Checkout at low power, and Low Power Dosimetry Irradiation. Significant operations of EP-III included: nominal full power operation for approximately 16 minutes, checkout of the power and temperature limiters, cross correlation measurements on the RPM loop at rated conditions, and checkout and operation with the No-Flux Temperature Controller. All facility systems operated satisfactorily and no major anomalies were noted except that the reactor shed could not be moved in over the Test Assembly at the completion of the test. (auth)

**21534** (NTO-R-0080) TEST REPORT FOR EXPERIMENTAL PLAN IV, NRX/A5 Test Series. Second Power Test. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 28 Jun 1966. 62p. Dep. NTIS $6.25.

Experimental Plan IV of the NRX-A5 Test Series was performed on June 23, 1966, at the Test Cell "A" facilities. Significant operations included: (1) Fixed Drum Startup from 30 kW to near rated conditions and (2) operation of the reactor at design point for approximately 14.3 minutes. All facility and control systems performed as expected and no major anomalies were noted. (auth)

**21535** (NTO-R-0087) NRX-A5 DOSIMETRY, DATA REPORT. Seibold, J. R. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Jul 1966. 15p. Dep. NTIS $15.00.

Dosemeters were evaluated after the low power NRX-A5 tests and normalized to neutron flux per watt for several locations in the vicinity. (LTN)

**21536** (NTO-R-0127) TEST REPORT, NUCLEAR EXHAUST SYSTEM DESIGN DEMONSTRATION TEST PROGRAM, PHASE I. Cramer, G. T.; Henze, H. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Oct 1967. 140p. Dep. NTIS $10.00.

The ETS-1 Nuclear Exhaust System (NES) Phase I Design Demonstration Test Program was conducted between 19 January and 7 February 1967 with a total of five tests being conducted. These tests used the Temporary Engine Compartment (TEC) to provide a reduced pressure containment chamber for the simulated engine and turbine nozzles since the Engine Test Compartment (ETC) was not operational. This represented the first combined operation of the Steam Generator System (SGS), with simulated engine flow through the NES duct. The tests were performed to evaluate the structural integrity and dynamic performance capabilities of the duct. Ambient temperature $GN_2$ was utilized for simulating the engine primary nozzle flow and for the TEC and duct inerting and purging flow. Ambient temperature $GH_2$ was utilized for simulating turbine exhaust fluid. These nozzles were positioned in the proposed XE engine location. The aerodynamic and inerting performance of the NES System are described. Generally the performance of the NES was within the predicted values. (auth)

**21537** (NTO-R-0129) NRX-A6 PRE-TEST REPORT. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 5 Dec 1967. 57p. Dep. NTIS $6.00.

The assembly of the NRX-A6 reactor and assembly or installation of components, coolant systems, and instrumentation was completed early in November, 1967, when it was transferred to test cell "C". Peripheral and central poison wires were removed during assembly and the required purge gas flow maintained. Pressure tests on the propellant feed line were made. (LTN)

**21538** (NTO-R-0130) TEST REPORT, EP-I NRX-A6 TEST SERIES. Initial Criticality, Flow Test, Drum Worth Measurements. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 21 Nov 1967. 71p. Dep. NTIS $6.75.

Experimental Plan I of the NRX-A6 Test Series was conducted on November 21, 1967, at Test Cell "C". The specific objectives were to determine the cold critical drum position of the reactor with the vertical shield in place and with borated water flow, to verify the operation of the control drums scram system, to measure the frequency response of the reactor power control and drums position control systems, to perform control drum integral and control bank differential reactivity worth tests, to perform automatic reactor startups, to determine the reactivity worth of the reactor vertical shield system, to irradiate dosimetry with the reactor at low power and to check out and evaluate other systems with respect to integrity and performance. All of the above objectives were successfully achieved. (auth)

**21539** (NTO-R-0132) TEST REPORT EP-II AND EP-III. NRX-A6 Test Series. System Interaction Checkout Full Power Run Aborts, December 6, 7, and 8, 1967. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 1967. 71p. Dep. NTIS $6.75.

Experimental Plans II and III of the NRX-A6 Test Series were carried out from December 6 to December 8, 1967, at Test Cell "C". The specific objectives of these experimental plans were as follows: To operate all systems and subsystems to verify their performance and to check for system interaction, and to provide a coordination run for all Control Room Operators and associated personnel in preparation for the Full Power Run. All of the objectives of EPII were achieved. The primary objectives of EPIII were not achieved, but reactor operation at a power level of 301 MW was achieved with satisfactory temperatures, pressures and differential pressures. (auth)

**21540** (NTO-R-0133) TEST REPORT EP-IIIA. NRX-A6 TEST SERIES. Full Power Duration Test. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 15 Dec 1967. 57p. Dep. NTIS $6.00.

Experimental Plan IIIA of the NRX-A6 Test Series was conducted on December 15, 1967, at Test Cell "C". The specific objectives were as follows: To evaluate the effects of Full Power Testing for 60 minutes on the structural integrity of the test assembly, to evaluate experimental fuel elements under the effects of Full Power Duration Testing, to evaluate the performance of the NRX-A6 test assembly design changes, to evaluate the nuclear and mechanical performance of the entire test assembly, to obtain data to be used in evaluating the performance of

several side-by-side experiments. All objectives were successfully achieved. The duration of the Full Power Hold was 60 minutes; the power integral was approximately $4.4 \times 10^8$ megawatt-seconds. The operation of all cooldown systems following the planned shutdown at 43 lb/sec was satisfactory. (auth)

**21541** (NTO-R-0134) SITE TEST REPORT FOR THE NRX/A6 TEST SERIES. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 9 Feb 1968. 184p. Dep. NTIS $12.25.

The NRX-A6 Test Series was successfully conducted at the Test Cell "C" facilities between November 21, 1967, and December 15, 1967. Accomplishments were: the reactor assembly operated at design conditions in a single cycle for 60 minutes, the integrity and adequacy of the emergency $LH_2$ cooldown system was demonstrated, the ability of the Filter Reactor Outlet Gas (FROG) to reduce contamination of the immediate area during $LN_2$ pulse cooling was proven, the reactivity worth of the reactor shield was obtained in several configurations, and a $GH_2$ accumulator system was used to provide protection against pressure oscillations in the propellant feed system in the event of an Emergency Shutdown. In general, the performance of the reactor was excellent. With few exceptions, reactor parameters (temperatures, temperature distribution, pressures, differential pressures) were in good agreement with pre-test predictions. Fuel element corrosion and the concomitant core reactivity loss during the full power test was less than predicted. The low reactivity loss allowed the achievement of the major test objective of 60 minutes at rated design conditions. There were few major operational problems. Some significant anomalies are discussed in detail. (auth)

**21542** (NTO-R-0136) NRX-A6 DOSIMETRY DATA REPORT. Seibold, J. R.; Donnelly, J. E. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Feb 1968. 39p. Dep. NTIS $5.00.

Several types of dosemeters were exposed on and around the NRX-A6 reactor assembly during low power and high power testing. The neutron fluxes at the various positions are recorded and the advantages and disadvantages of the various types of dosemeter discussed briefly. (LTN)

**21543** (NTO-R-0139) NEP-HE-1, NEP-HE-2. SPEAR Team Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 14 Mar 1968. 154p. Dep. NTIS $10.75.

The NEP-HE-1 and NEP-HE-2 tests were conducted on March 1 and 8, 1968, at ETS-1 to demonstrate the helium system designed to prevent air ingestion into the NES duct and the engine test compartment in the event of a steam generator malfunction. The safety system consists of two pressure detectors, each of which sense the loss of steam pressure and a fast acting valve, PCV-449, which delivers helium into the engine test compartment from high pressure bottles preventing the backflow of air when the steam ejector system ceases its pumping action. The safety system is intended to be activated only during a critical period in engine startup and shutdown when hydrogen is in the system and engine pumping is insufficient to prevent air backflow. The helium system is, therefore, only necessary below 60 psia on both startup and shutdown and does not consume helium unless the steam generators fail. The helium system was completely successful in preventing backflow. A total of seven simulated steam generator failures were conducted and, in all tests, air did not flow back into the NES duct during the test compartment repressurization. This was proven by high speed movies, oxygen analyzers, and repressurization calculations. (auth)

**21544** (NTO-R-0142) THREE-DAY REPORT FOR EXPERIMENTAL PLAN I. XECF Test Series. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 2 Apr 1968. 52p. Dep. NTIS $5.75.

XECF Experimental Plan I was performed on April 2, 1968 at the ETS-1 Test Facility. The cold flow test was performed with a 35 psia run tank pressure with the turbo-pump initially warm. The purpose of this test was to confirm bootstrapping from this initial run tank pressure. Although this test was successfully performed, the actual bootstrap was delayed longer than expected following the opening of PSV. The remaining runs planned were not initiated due primarily to the insufficient remaining $N_2$ inventory for facility inerting. Malfunctions in the digital data systems resulted in significant data losses before and during the $LH_2$ flow phase. (auth)

**21545** (NTO-R-0155) FDET REPORT FOR FEP-V-I, IA, IB. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 21 Aug 1968. 326p. Dep. NTIS $19.50.

The initial flow tests with liquid hydrogen on the ETS-1 test facility are described. Although system leaks and high usage of hydrogen prevented completion of the planned tests, a considerable amount of information was obtained on cooldown times for the system, hydrogen losses required for chill maintenance, the performance of vent systems, flow impedances and pressure control system responses. Certain simulation experiments (reactor startup, reactor shutdown, etc.) were carried out. A number of recommendations are made and specific results are described in 29 memos. (LTN)

**21546** (NTO-R-0157) FDET REPORT FOR FEP-V-II, IIA, IIB AND CV-EP-I. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 30 Sep 1968. 593p. Dep. NTIS $32.75.

The tests on ETS-1, the significant results and recommendations based upon the FDET analyses, performed for FEP-V-II, IIA, IIB and CV-EP-I between 22 August and 12 September 1968 are summarized. These tests provided sufficient data for evaluation of the capability of the engine PDKV and cooldown systems to support engine testing. Results on specific systems or components are given in 31 memos. (auth)

**21547** (NTO-R-0161) NES STEAM LINE DESIGN DEMONSTRATION TESTS. Phase I Separator Checkout. Spear Team Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 18 Oct 1968. 110p. Dep. NTIS $8.50.

The SPEAR Analyses for Phase I NES Steam Line Demonstration Tests conducted on October 3 and 9, 1968 are summarized. These tests were performed at ETS-1 to check out the Steam Separator installed to prevent water entering the steam line during emergency shutdown of the SGS. In addition, water interaction information was obtained to evaluate the water coverage provided by the test stand cooling system and the modifications to the duct discharge water piping. All test objectives were successfully met. Several anomalies occurred during the test series, the majority of which were due to component failures. Thirty-one recommendations for changes or further study are made. Detailed results are included in ten SPEAR memos. (auth)

**21548** (NTO-R-0164) XE-PRIME EP-1 INITIAL CRITICALITY AND EP-SL2 STEAM LINE. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). 18 Dec 1968. 242p. Dep. NTIS $15.25.

Experimental Plan I of the XE-Prime Test Series was performed on December 4 and 6, 1968, at ETS-1 of the Nuclear Rocket Development Station, Jackass Flats, Nevada. Significant operations included: initial criticality, control system checks, S-1 shield water worth measurements, low power dosimetry irradiation and drum worth checks. Water flow and steam line checkout operations were included and designated as EP-SL2. (auth)

**21549** (NTO-R-0166) XE-PRIME EP-1A DRUM AND SHIELD WORTH, THERMAL CALIBRATION, AND DOSIMETRY IRRADIATION. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Feb 1969. 129p. Dep. NTIS $9.50.

Experimental plan IA of the XE-prime Test Series was performed at ETS-1 on February 20, 1969. The objectives were: Thermal calibration at 1 MW, nuclear autostart at 100 KW, measurement of S1 Shield Worth and Control Drum Worths, and check of intermediate power dosimetry. The objectives were met. Specific results are covered in 17 SPEAR Memos (2 are classified and appear in a supplement). Recommendations are made. (LTN)

**21550** (NTO-R-0167) XE-PRIME EP-1B STEAM GENERATOR CHECKOUT AND ENGINE INTERACTION TEST. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Mar 1969. 191p. Dep. NTIS $12.75.

Experimental plan IB of the XE-Prime Test Series was conducted at ETS-1 on February 27, 1969. Certain parts of the Steam Generating System were checked out. The operation of control drums and the turbine power control valve with hydrogen as the actuating gas was checked. Cooling system modifications were tested. Also it was verified that no scram-producing interactions existed between the engine and test facilities. Specific results are covered in 17 SPEAR Memos included. Certain anomalies are recorded and recommendations are made. (LTN)

**21551** (NTO-R-0168) XE-PRIME EP-IIA. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Mar 1969. 502p. Dep. NTIS $28.25.

EP-IIA of the XE-Prime test series was conducted on 20 March 1969. This test was the first start, to significant power, of a down firing nuclear engine under simulated altitude conditions. The test consisted of three nuclear powered bootstraps to pressure and temperature loop closure. The objectives of EP-IIA were to: Check out the system under $LH_2$ flow conditions, verify valve sequencing and instrumentation performance, verify control system temperature loop closure, and confirm predictions of initial portions of XE startup. These objectives were met. Variations from predictions were observed during this EP and are discussed in detail; however, no conditions were observed that would preclude performing EP-III. Specific results are discussed in 60 SPEAR memos and 16 recommendations are made. (auth)

**21552** (NTO-R-0172) XE-PRIME EP-4A STARTUP TESTS. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Jul 1969. 272p. Dep. NTIS $16.75.

EP-4A of the XE-Prime test series was successfully conducted on 26 June 1969. The objectives of XE-Prime EP-4A were: To demonstrate a dry temperature autostart to a very low power level, demonstrate a wet temperature autostart to a very low power level, obtain drum and run tank pressure step response measurements at low power levels, investigate startup and restart with closed loop temperature control and low chamber pressure coincidence demand, and obtain final post test xenon measurements for EP-5. All of these objectives were met. The dry and wet temperature autostarts of EP-4A demonstrated the first known startup of a Nuclear System without an active flux control loop. A number of recommendations are made and specific results are discussed in 23 SPEAR memos. (auth)

**21553** (NTO-R-0173) XE-PRIME EP-6A STARTUP TESTS. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Jul 1969. 311p. Dep. NTIS $18.75.

Experiment Plan 6A of the XE-Prime Test series was successfully conducted on 10 July 1969. The overall objectives of EP-6A were: To obtain information on engine start characteristics using temperature autostarts without an active neutronic flux control loop, obtain information on minimum run tank pressure at which engine startup can be achieved, and obtain engine steady state and dynamic response data in the low region of the engine operating map. All engine components performed satisfactorily with no apparent condition that would prevent future testing. The Nuclear Exhaust System operated satisfactorily without any major anomalies. The Steam Generator System was operated at full steam conditions for 52 minutes. Specific results are discussed in 24 SPEAR memos. Sixteen recommendations were made. (LTN)

**21554** (NTO-R-0174) XE-PRIME EP-7A STARTUP TESTS OPEN LOOP. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Jul 1969. 322p. Dep. NTIS $19.25.

Experimental Plan 7A of the XE-Prime Test Series was conducted on 24 July 1969. The overall objectives of the EP-7A were: To obtain information on engine startup characteristics with open loop control, on minimum run tank pressure at which engine startup can be achieved, on sensitivity of temperature autostarts to sequencing of engine flow, on sensitivity of temperature autostarts to drum program, on engine dynamic response data at low power operating conditions, and establish TPCV position for bootstrapping and sustained engine operating threshold. All of the planned tests were completed except Runs 3, 6, and 8 and test objectives were met except for the low power transfer function data, minimum TPCV position for bootstrapping and sustained engine operation, the effect of delayed engine flow on temperature autostart and the effect of an exponential drum ramp to critical position plus 13 degrees. The results indicate that a liquid hydrogen condition is necessary at the pump inlet for sustained engine bootstrapping and more than 20 psia tank pressure is required for this purpose. The nuclear subsystem performed satisfactorily. All pressures and temperatures remained well within the test limits and accepted operating ranges. All non-nuclear engine components performed satisfactorily. The test results indicated that the pump experienced a cavitation head loss, during the attempted bootstrap with a 20 psia tank pressure, as a result of a saturated liquid condition at the pump inlet. (auth)

**21555** (NTO-R-0175) XE-PRIME EP-8A PHYSICS AND STARTUP TESTS. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Aug 1969. 333p. Dep. NTIS $19.75.

The objectives of XE-Prime EP-8A were: To obtain engine chilldown characteristics at a reduced run tank pressure, obtain information on reactivity effects with low temperature engine conditions, obtain information on engine startup and shutdown characteristics with open loop control, obtain information on characteristics of ON/OFF temperature controller, obtain information on sensitivity of (core) temperature autostarts to drum program profile, obtain information on sensitivity of (chamber) temperature autostarts to source power level and initial core temperatures, obtain engine dynamic response data for TPCV and drum position demand perturbations, and evaluate engine operating characteristics with reduction of TPCV position. All tests were completed. Although there were deviations from the planned conditions and test operations, all of the objectives of EP-8A were met. A description of the pre-run operational difficulties and the chilldown and Physics Tests is presented. The performance of the nuclear sub-systems was normal during EP-8A with the temperatures and pressures remaining within the established limits. The engine valves, turbopump, lines, thrust structure and pressure vessel performance and the engine system vibration data were evaluated and it was established that these components were in satisfactory condition for continued testing. The Nuclear Exhaust System satisfactorily supported the EP to the planned conclusion of the EP. Two generators were operated at full steam for 60.5 minutes at a nominal steam temperature of 1290°R. The post-test inventory indicated a maximum of seven minutes of operating time remaining when the SGS was shutdown. Based on the analysis conducted by SPEAR following EP-8A the engine and facility systems are considered to be in acceptable condition for continued testing in EP-9A. (auth)

**21556** (NTO-R-0179) XE-PRIME EP-9A HIGH ISP STARTUP TESTS. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Sep 1969. 313p. Dep. NTIS $18.75.

The planned EP-9A tests of XE-Prime were only partially successful. Most of the planned reactor startups from low temperature resulted in period scrams. It was concluded that planned or inadvertent chilling of the reactor significantly below ambient conditions increased the reactivity and reduced control drum worths to the point that control of the reactor was difficult to achieve when hydrogen insertion occurred in attempted startup. Otherwise, all nuclear and nonnuclear components performed satisfactorily and were in suitable condition to support continued testing. Specific results are given in 27 SPEAR Memos. (LTN)

**21557** (NTO-R-0180) XE-PRINE EP-10A (DRY) TEMPERATURE AUTO STARTS, LAMINAR FLOW TESTS. SPEAR Report. (NERVA Test Operations, Jackass Flats, Nev. (USA)). Sep 1969. 170p. Dep. NTIS $11.50.

The concluding Experimental Plan, EP-10A, of the XE-prime Test Series was carried out September 11, 1969. It involved (Dry) Temperature Autostat Tests (without bootstrapping) and Laminar Flow Tests with liquid and gaseous hydrogen to provide information on temperature asymmetries at low flow rates. The objectives were essentially met. Conclusions and recommendations are given. Eleven SPEAR memos are included. (LTN)

**21558** (NRTO-R-0202) FINAL TEST REPORT FOR PEWEE 2 INTEGRATED FACILITY TEST SERIES (FEP I AND FEP II). (NERVA Test Operations, Jackass Flats, Nev. (USA)). 11 Dec 1970. 345p. Dep. NTIS $20.25.

The Pewee 2 Integrated Facility Test Series was performed to provide a final integrated checkout of certain Test Cell "C" facility systems and operating procedures prior to the conduct of the Pewee 2 reactor tests. The test objectives and test system operational requirements established preceding the tests are given in the FEP-I Test Description, NRTO-R-0193; and the FEP-II Test Description, NRTO-R-0199. The test series was successfully completed on October 8, 1970. The results are described in detail. (auth)

**21559** (RN-DR-0055) MULTIPLE EXHAUST NOZZLES FOR NUCLEAR ROCKET ENGINES. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1965. 120p. Dep. NTIS $9.00.

The multiple-nozzle concept investigated in this study consists of a cluster of sixty asymmetric nozzles placed in a circular pattern around a single conventional nozzle. Each of these nozzles has a circular cross-section at the throat station, whereas the geometry of the exit plane is a sector of an annulus. This nozzle array was adopted so as to completely utilize the available area at the multiple-nozzle exits and, more important, to provide an enclosed region between adjacent nozzles which would serve for coolant passages. In this concept, the overall nozzle area ratio at the exit station of the cluster is nearly equivalent to that of a conventional nozzle of the same general geometric dimensions. The nozzle design, moreover, incorporates a conical shroud downstream of the multiple nozzle exit to provide additional nozzle flow expansion. Whereas for single nozzle consideration, shock losses are considered to be associated with performance losses, the experimental data indicate that the shrouded multiple-nozzle system actually derives a measurable performance benefit from the effects of the juncture shocks at the shroud surface. The result of both theoretical and experimental analysis of the multiple-nozzle design concept shows that this concept will result in minimum nozzle over-all length with minor performance loss. For the NERVA engine application a weight reduction of approximately 35% is possible when compared to an equivalent conventional convergent-divergent nozzle. The overall increased engine payload based on interstage weight reduction would be about 1930 pounds. Thrust efficiencies of 95 to 97 percent were attained. (auth)

**21560** (RN-DR-0068(Vol. 1)) NUCLEAR ENGINE TRANSIENT ANALYSIS PROGRAM. Volume I. Test, Program Nomenclature, and Fortran Listings. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1965. 291p. Dep. NTIS $17.75.

The Nuclear Engine Transient Analysis Program (NETAP) is an IBM 7094 digital computer program which simulates the

low frequency transient and the steady-state operation of the NERVA hot-bleed engine, the NRX reactor test system, and the Cold Flow Development Test System, over the full operational range of temperatures and pressures. This simulation includes an analytical description of each engine component, including the nozzle, reflector, shield, core, turbine inlet line heat exchanger, and turbopump. All of these component calculations are performed in sufficient detail to provide an accurate determination of the energies added or subtracted from the fluid, the pressure drops, the flow rates, and the component operating temperatures. A modified relaxation method is used to solve the heat transfer and pressure drop equations. (auth)

**21561** (RN-DR-0082) POST NRX/EST TURBINE POWER CONTROL VALVE ACTUATOR (S/N 18) EVALUATION. Krauter, K. E.; Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1966. 45p. Dep. NTIS $5.25.

Post-NRX/EST performance tests of the turbine power control valve-actuator assembly (TPCV S/N 18 and actuator S/N 18) did not reveal any performance deterioration because of NRX/EST use. Electrical noise in the amplifier (which probably existed prior to NRX/EST testing) may have contributed to what appeared to be actuator problems during EP-IVA. While this specific problem can be solved, engine and test-stand noise (electrical and mechanical) can seriously affect TPCV actuator performance. The actuator-system noise characteristics must be improved by changing the amplifier compensation. When changing this compensation, system dynamic and static resolution also should be improved. The actuator operation time was estimated to be about 65 hours. The magnetic amplifier driving the diluent control valve actuator was found to be inoperative: consequently, no performance tests were conducted. Considerable radioactive contamination was found on TPCV and DCV actuator surfaces. (auth)

**21562** (RN-DR-0084) ELECTRO-PNEUMATIC SERVO ACTUATOR EVALUATION PROCEDURE. Funnell, W. F.; Krauter, K. E.; Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1967. 46p. Dep. NTIS $5.50.

Engineering evaluation procedures for Bendix Actuator P/N 2775030, the NERVA turbine power control valve actuation subsystem, are defined. Test equipment is listed. Actuator system tests described are: step response, linearity, system error, closed loop frequency response, threshold and stall torque. (auth)

**21563** (RN-DR-0128) TURBINE POWER CONTROL VALVE ACTUATOR PERFORMANCE EVALUATION. Vibration Test. Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1967. 41p. Dep. NTIS $5.25.

The vibration test of the Bendix Model NT-D1 Turbine Power Control Valve Actuator (TPCVA), Serial No. 17, is described. This test is part of the overall qualification test and was performed in accordance with the requirements of RN-S-0425, Qualification Test Plan, Bendix Model NT-D1 Turbine Power Control Valve Actuator. The entire test was conducted through completion using both sinusoidal and random vibrations. Performance tests conducted before and after each vibration test indicated no appreciable changes in performance. No deterioration in performance was noted during the vibration testing (either sinusoidal or random) when conducted in accordance with the applicable specification. In the Y axis only, performance deterioration was noted during dwell at a 573 cps resonant point. However, the maximum input vibration frequency for the Y axis, specified in NDC-51A, Actuator, Electro-Pneumatic, Rotary, for Turbopump Power Control Valve, is 500 cps at 1 g. (auth)

**21564** (RN-DR-0130) HUMIDITY TEST. Model NT-D1 Turbine-Power-Control-Valve Actuator Qualification. Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep. 1967. 24p. Dep. NTIS $4.25.

A Bendix Model NT-D1 turbine-power-control-valve actuator was subjected to a humidity test to determine if elevated temperature and moisture would adversely affect the performance of the unit. Test data indicated that actuator performance was not significantly affected by the humidity test. (auth)

**21565** (RN-DR-0131) ENDURANCE TESTING OF TURBINE POWER CONTROL VALVE ACTUATOR, BENDIX MODEL NO. NT-D1, SN 17. Harris, W. P. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1967. 74p. Dep. NTIS $6.75.

Prior to the Endurance Test portion of the Qualification Test, the test actuator had been subjected to 60.4 hours of usage under various conditions. The endurance test consisted of sinusoidal cycling of the actuator at 0.3 cps against a resistive torque whose peak amplitudes were 400 lb-in. in the clockwise (opening) direction, and 80 lb-in. in the counterclockwise direction (looking into the actuator output shaft end). During the torque cycling, the actuator mounting flange temperature was reduced during a 1-hr period to −230°F; increased to +600°F during a 2 to 2-½ hr period, then was cooled to 400°F, at which point the torque cycling was stopped. Later information revealed that the output shaft had inadvertently reached temperatures of approximately 1000°F (1460°R). Total time of endurance test cycle, including the time to return to ambient temperature and to complete the performance reference test was 8 hr. Total time of operation for this test actuator is 68.4 hr; NDC51A, the criterion to which this model TPCV actuator was procured, established the operating life at 20 hr. Pretest and posttest data, as well as data recorded during the test, were not significantly different. In view of this fact and the extensive prior usage, the actuator is considered to have exhibited sufficient endurance for application in the technology engine program. Following the endurance test and during a test stand torque calibration test, it was discovered that the actuator exhibited limit cycling when stepped to a certain position. Further investigation revealed that the actuator was prone to limit cycling at intervals of 1.3° of actuator position, while operation between these positions appeared normal. The limit cycling was at a frequency of 25 cps and at a 0.3° peak-to-peak amplitude. Subsequent disassembly of the actuator revealed transmission gear wear and rough-running bearings. This bearing and gear wear may have resulted from temperatures at the input shaft that were higher than originally planned. Discoloration of the shaft and seal was evidence of the high temperature. However, inadequacies in the transmission gearing design appear to be major and possibly more significant contributing factors. (auth)

**21566** (RN-DR-0141(Rev.A)) XE-1 ENGINEERING ASSEMBLY FAILURE MODE ANALYSIS. Rotter, J.; Gallagher, H. F.; Henderson, R. A.; Wark, F. H. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1968. 176p. Dep. NTIS $12.00.

The XE-1 Nerva Engine Failure Mode Analysis, Revision "A" updates the earlier issue. Sources of new data include the Facility Safety Report, RN-S-0378, XE-1 Safety Analysis Report, NJD9, and component development, engineering and analytical reports. Pertinent component anomaly and failure data were obtained from available test reports and discrepancy documents (IR's, DIR's, QRDR's). The engine line assembly narrative and the piping and instrumentation diagram have been added to facilitate understanding and application of this analysis. (auth)

**21567** (RN-DR-0173) TREE ANALYSIS CODE (TRACE) PROGRAM E64106. Throckmorton, T. N.; Tayama, H. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1969. 107p. Dep. NTIS $8.50.

The TRACE Program is used to determine the probability, and the most likely sources, of a specific failure of a nonrepairable complex system prior to a specified time. The systems considered are binary-response structures that can be represented by a fault tree. A fault tree is a logic diagram, in which an output event (undesired system state or fault) is related by logic operations symbols to input events that may be lower-level system states, component states, command-function faults, or basic component failures. For this program, the component failures provide the basic input events, which are assumed to have independent time-to-failure probability distributions. The gates describe the logical relationships between events and the manner in which they may combine to produce other events, including the top event or system failure. Because large systems with logically complex structures preclude analytic solution, computer simulation is used; but, when system failures are rare, direct simulation becomes impractical. In this situation, the Monte Carlo technique of importance sampling is used to reduce the required sample size and improve efficiency by large multiples. (auth)

**21568** (RN-S-0067) AEROJET RESPONSE TO CONTRACT SNP-1 CONTRACT YEAR 1963 PRELIMINARY REVIEW. (Aerojet-General Corp., Azusa, Calif. (USA)). 6 Mar 1964. 115p. Dep. NTIS $8.75.

Criticism of Aerojet General's performance of the 1963 contract work in a preliminary review by SNPO led to a long, detailed justification of it by Aerojet-General Corp. on the basis of difficult technical development problems, redirection of effort, etc. along with its own satisfaction with its performance and consultant support. Also included is a strong criticism of the method of evaluation by SNPO. (LTN)

**21569** (RN-S-0081) NERVA ENGINE SYSTEM TASK FORCE MEETING. (Aerojet-General Corp., Azusa, Calif. (USA)). 7 Apr 1964. 30p. Dep. NTIS $4.75.

A presentation of NERVA research programs to the Space Nuclear Propulsion Office (SNPO) on April 7, 1964 is documented. It involves plans, test facility modifications required with cost estimates, status of various programs, projections, etc. (LTN)

**21570** (RN-S-0082(Rev. 5)) SUPPORT EQUIPMENT TECHNICAL DESCRIPTION HANDBOOK. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1968. 388p. Dep. NTIS $22.50.

Current technical descriptions of all nonnuclear Ground Support Equipment (GSE) for the NERVA NRX and XE test series and most of the nuclear GSE through the NRX-A5 series are provided. (auth)

**21571** (RN-S-0092) REVIEW OF NERVA HEAT TRANSFER ANALYSIS. (Aerojet-General Corp., Azusa, Calif. (USA)). Jun 1964. 75p. Dep. NTIS $6.75.

A review of presently available information regarding heat transfer correlations and pressure drop predictions for hydrogen flow in the various phases encountered in normal nuclear rocket operation is presented. Recommendations are made concerning specific equations to be used for selected ranges of temperature and pressure. In the case of forced convective boiling heat transfer, much additional study both experimental and analytical must be accomplished before suitable equations are available for use in design. Abnormal heat transfer and fluid flow phenomena which could result in problems within a reactor during phases of operation are also discussed. A discussion of the digital computer codes presently available at WANL for analysis of the reactor during various phases of operation is presented in Part 2. (auth)

**21572** (RN-S-0092(Rev. A)) REVIEW OF HEAT TRANSFER ANALYSIS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1965. 18p. Dep. NTIS $4.00.

REON Report RN-S-0092, issued June 1964, presented and discussed the heat transfer and pressure drop correlations together with the digital computer codes available at WANL for use in predicting the heat transfer and fluid flow phenomena for each of the operating phases encountered in normal reactor operation. Since that date, new information pertinent to the operation of the NERVA system has appeared. This report is a review of the heat transfer literature appearing between the publication of RN-S-0092 in June 1964 and June 1965. While significant contributions toward advancing the "state of the art" have been made, it is concluded that the recommended equations presented in Report RN-S-0092 are still valid and no changes are required at this time. Further work is recommended in some areas, such as forced convective boiling and the relation between heat transfer and friction factor. (auth)

**21573** (RN-S-0142) NERVA CAST NOZZLES CONTACT CONDUCTANCE EVALUATION PROGRAM. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 144p. Dep. NTIS $10.25.

Studies were conducted to determine NERVA nozzle thermal contact conductance between the cast aluminum jacket and stainless steel coolant tubes. This work was initiated to verify that the thermal contact was sufficient to remove radiation-generated heat from the jacket. It was concluded that the conductance was more than sufficient and that no problem existed. (auth)

**21574** (RN-S-0146) DATA ANALYSIS TECHNIQUES. (Aerojet-General Corp., Azusa, Calif. (USA)). Oct 1964. 357p. Dep. NTIS $21.00.

Data analysis techniques developed during Contract Year 1964 are described. An evaluation of these techniques was made by their application to the NRX-A1 test data. They proved useful for analyzing that data, although a need for improvements and continued development was indicated. New data analysis techniques currently under development are also described. These are primarily concerned with comparing model predictions to actual test data, and interpreting this comparison when both the data and the model are subject to error. Computer Job No. 364, which is described in a companion report, is the basis for this comparison. The purpose of the comparison is to utilize the results of actual tests to upgrade Aerojet's analytical representation of systems behavior. Hardware useful for acquisition, processing, and analysis of engine test data is also discussed. (auth)

**21575** (RN-S-0156) AEC–NASA SPACE NUCLEAR PROPULSION OFFICE MINUTES OF THE THIRD QUARTERLY NERVA INSTRUMENTATION MEETING. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1964. 70p. Dep. NTIS $6.50.

**21576** (RN-S-0196) NRX-A PRESSURE VESSEL CLOSURE SEAL CRYOGENIC TEST SERIES I. Evaluation Report. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1965. 33p. Dep. NTIS $4.75.

Declassified 17 May 1965.

NRX-A pressure vessel closure seal cryogenic test series I and evaluation of the test results are described. Pressure vessel closure seals were tested at ambient and cryogenic temperatures using both helium and hydrogen test gases. (auth)

**21577** (RN-S-0204) PERFORMANCE TEST REPORT AND OPERATION MANUAL ON CFDTS SEQUENCER. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1965. 97p. Dep. NTIS $8.00.

A NERVA Cold Flow Development Test System sequencer has been constructed to control and monitor the bootstrap capability of the XE-Engine. The requirements, design details, operation and performance test results of the sequencer are presented. (auth)

**21578** (RN-S-0231) XE-1 ENGINE ESTIMATED WEIGHT AND BALANCE REPORT. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 18p. Dep. NTIS $4.25.

Revised engine weight and center of gravity, component weights and centers of gravity, are presented. The engine reported on utilizes an aluminum pressure vessel and a steel-jacketed hot bleed port nozzle. (auth)

**21579** (RN-S-0232(Rev.)) NRX/EST TEST PREDICTION REPORT. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Nov 1965. 182p. Dep. NTIS $12.25.

The NRX/EST test will be the first test of a complete engine system in the NERVA program. The tests are designed to demonstrate the feasibility of the hot-blood cycle, nuclear-engine system to accomplish bootstrap startup into the power region and operate at full power. In preparation for these tests, and as an aid in their rapid evaluation a detailed analysis of the system has been performed with the results recorded in this Test Prediction Report. The objectives of the Test Prediction Report are: (1) to ensure that the tests as planned can be accomplished in a safe manner, (2) to provide means of quickly evaluating test data during the various test phases, (3) to ensure that emergency safety measures are adequate if required, and (4) to provide a means of evaluation of the analytical programs. The test article will use the NRX-A4 reactor, a Mark III Mod 4 turbopump, a U-tube nozzle with a bypass hot bleed port and a counter-current heat exchanger. The engine will be fired nozzle-up using a modified NRX text car. (auth)

**21580** (RN-S-0235(ADD.4)) FINAL TEST SPECIFICATIONS FOR PHASE 1-C OF THE COUNTERMEASURES RADIATION EFFECTS PROGRAM. Volume 1. Test and Unclassified Appendixes. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 109p. Dep. NTIS $8.50.

A program has been initiated to investigate radiation effects on high explosives and propellants as they pertain to the NERVA Countermeasures System. The test specifications presented include descriptions of the experimental procedures to be used to determine the most radiation-resistant high explosives and propellants. These procedures will involve gathering data on weight loss, gas release (continuous and point measurement), thermogravimetric analysis, explosion temperature, differential thermal analysis, and vacuum stability—all as a function of integrated radiation energy deposition. Then data will be obtained on mild detonating fuzes (MDF) made with booster and main charge type explosives, while selected cast and extrudable propellant strands will be burned to evaluate possible changes due to radiation. (auth)

**21581** (RN-S-0238) INSTRUMENTATION EVALUATION NRX-A3 TESTS. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1965. 129p. Dep. NTIS $9.50.

An evaluation of the test results of the NRX-A3 tests for the NRX-A3 instrumentation kit is presented which includes the following information: location and requirements of the measurement parameters; description and basis of selection; development; pre- and post-test evaluation; and degree of reliability and anticipated performance for future use. (auth)

**21582** (RN-S-0240) AGC-WANL: COMMON MODEL FOR ANALOG COMPUTER. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1965. 13p. Dep. NTIS $4.00.

In accordance with agreements reached at the Systems Analysis Meeting held between WANL, AGC and SNPO personnel at WANL on 6 April 1965, an equation set has been developed which describes the NERVA systems. These equations are documented here. (auth)

**21583** (RN-S-0242) SECONDARY EJECTOR STUDY. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1965. 110p. Dep. NTIS $8.50.

The analytical and experimental evaluation of the scale-model, annular-nozzle, secondary ejector test program of Contract Year 1965 is discussed. Three annular nozzle ejectors were tested and evaluated to determine the effects of ejector nozzle area ratio, total pressure, primary and secondary fluid properties (temperature, pressure, and molecular weight), and primary inlet Mach number. The design procedure for a primary diffuser and a

secondary ejector are defined and an illustrative example is included. (auth)

**21584** (RN-S-0294) CFDTS DATA ANALYSIS FINAL REPORT. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1966. 89p. Dep. NTIS $7.50.

Twenty-five tests conducted with the Cold Flow Development Test System during October and November of 1965 have been analyzed. These tests further demonstrated the ability of the NERVA engine to bootstrap under a wide range of tank pressures and turbine and nozzle back pressures, including the test conditions for the NRX/EST program and the ETS-1 design conditions. Bootstrapping with the pump in a prechilled (wet) as well as a warm ambient (dry) condition was demonstrated. A period of oscillations in the pump performance was encountered in the tests with a dry pump at start; however, the oscillations did not affect the ability of the system to bootstrap or produce any critical condition during the CFDTS tests. Closed-loop control of the turbine power control valve to control nozzle chamber pressure during start was effected, pointing the way to future system simplification through elimination of the TPCV programmed position control. (auth)

**21585** (RN-S-0295) XECF TEST PLAN. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1966. 40p. Dep. NTIS $5.00.

The XECF Test Program is defined to serve as an engineering basis for the conduct of the tests. It includes a description of the test item, the objectives, tests to be performed, engine assembly and installation, post-test operations and other pertinent information. It provides the information necessary to initiate detailed planning for the test and forms a basis for all test documentation. (auth)

**21586** (RN-S-0297) THRUST CHAMBER TEMPERATURE PROFILE PROBE. Summary Report. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1966. 18p. Dep. NTIS $4.00.

A feasibility study has been made of a device for measuring the profile of the NERVA thrust chamber gas temperatures in approximately half of the cross-sectional plane near the hot bleed port. The proposed device consists of a streamlined tubular arm mounted on a pivot in the hot bleed port, six tungsten-rhenium thermocouples protruding from the front edge of the arm, and a drive mechanism to swing the arm back and forth across the thrust chamber. The proposed device is technically feasible. The drive mechanism, thermocouples and arm structure represent direct applications, or extensions, of existing hardware or techniques and all stresses are within limits of a high temperature alloy such as tungsten 26% rhenium. Building and testing this device would require about one to two years and cost about $250,000.00. Extensive nonnuclear testing would be necessary to demonstrate the adequacy of the design prior to testing in the NRX or XE vehicle. In view of the close agreement between the individual thermocouples used on all NRX tests conducted to date, and in view of the agreement between the average measured and calculated temperatures, it is considered improbable that large temperature gradients exist across the nozzle. Therefore, the large expenditures required to make temperature profile probe type measurements may not be justified at this time. (auth)

**21587** (RN-S-0300) THERMAL AND ERROR ANALYSES FOR THERMAL CONDUCTIVITY TEST 37/R004. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1966. 58p. Dep. NTIS $6.00.

The errors and thermal analysis problems for the effects of radiation on thermal conductivity test, 37/R004, to be performed during the GTR-18 run at General Dynamics' Fort Worth Facilities are reported. The error analysis includes: Input power measurement, dewar pressure measurement, temperature measurement, and test specimen electrical resistance measurements. The thermal analysis includes: The time required to chill test specimens and test cells from ambient temperature to liquid hydrogen with a vacuum in the test cell, the power requirements to achieve equilibrium for specified temperature gradients across test specimen, the maximum temperature gradient between the heater element and the heat sink during irradiation, the heat loss from heater power leads and the instrument leads during the conductivity measurements, and the time to reach equilibrium at each hold temperature for each material. The materials to be investigated include titanium, inconel, aluminum, steel, graphite and beryllium. (auth)

**21588** (RN-S-0303) EVALUATION OF NRX-A3 PRESSURE VESSEL. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1966. 32p. Dep. NTIS $4.75.

The pressure vessel assembly, to include pressure vessel cylinder S/N 006, pressure vessel closure S/N 003, nozzle/cylinder seal S/N 056, cylinder/closure seal S/N 089, 120 closure bolts and 120 closure bolt seals, has been evaluated for its performance and integrity during the third reactor experiment, NRX-A3. The pressure vessel again successfully demonstrated its ability to contain all pressure and environmental loadings and function satisfactorily during a long duration reactor test. No major anomalies in pressure vessel performance were noted. (auth)

**21589** (RN-S-0304) EVALUATION OF ALTERNATE CONTROLS FOR THE TECHNOLOGY ENGINE. Kornfeld, E. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1966. 32p. Dep. NTIS $4.75.

Studies of alternate control systems for the NERVA engine were made and compared with systems already employed. The purpose of all studies was to achieve both a simpler and better performing control system. The NERVA engine is limited to control by two methods: changing reactivity and turbine power throttling. The several variables and three options within these constraints are discussed. Primary concern in all systems is frequency response and stability. Both the effects of coupling and uncoupled performance are described, as are the phase and gain characteristics of a control system with the flux loop removed. Emphasis is given to a modified temperature control (similar to the system employed for Phoebus testing), pressure control by drum motion, and to fixed drum control systems. The advantages and disadvantages of each are cited. Also discussed are the effect of startup and shutdown transients and the use of a closed-power-loop during transient conditions. For startup, a fuel-temperature controller is described as best: for shutdown, the best system is seen to be temperature control of the TPCV after scram. (auth)

**21590** (RN-S-0309A) NRX/EST DATA ANALYSIS FOR FLUID OSCILLATIONS AT INTERMEDIATE PRESSURES. Dowling, E.; Kasahara, M. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1967. 55p. Dep. NTIS $5.75.

Oscillations during NRX/EST low-power testing were caused by the transition from two-phase to supercritical conditions in the nozzle tubes. This transition resulted in rapid changes in nozzle-tube heat transfer, flow resistance, and outlet density which were sufficiently rapid to create a temporary imbalance in flow from the reflector inlet plenum. The engine responded to the changed nozzle-tube flow resistance and the temporary flow imbalance by creating nozzle conditions which reversed the phase at the nozzle-tube out-let. This, in turn, sustained stable oscillation in the engine system. It has not been possible to isolate the net effect of pressure-control-loop feedback on engine oscillations. Engine structural integrity was not endangered during the oscillations which were confined to intermediate pressures. Test data indicate that oscillations can be eliminated entirely during ramp-up and ramp-down by increasing the nozzle heat-transfer so nozzle-tube flow will not cross the top of the two-phase dome but rather the saturated vapor-curve side of the two-phase dome. This can be accomplished by revising the chamber pressure-temperature schedule to give higher temperatures when passing the critical pressure point. (auth)

**21591** (RN-S-0318) SUMMARY OF RADIATION EFFECTS INFORMATION GAINED FROM NRX-A2 AND NRX-A3. Greenhow, W. D.; Hankowsky, J. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1966. 31p. Dep. NTIS $4.75.

The radiation effects information gained from NERVA reactor tests on NRX-A2 and NRX-A3 is reported. The results of component tests and materials tests performed in conjunction with these experiments and/or gained through post-mortem examination are discussed and recommendations are presented for maximizing information from future tests. (auth)

**21592** (RN-S-0331) EXPERIMENTAL COOLDOWN OF AN ALUMINUM-JACKET, TUBE-BUNDLE, NERVA TECHNOLOGY NOZZLE. Thompson, W. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1966. 93p. Dep. NTIS $7.75.

The results of a test program to determine the cooldown characteristics of a full-scale NERVA technology engine, using a cast-aluminum-jacket, tube-bundle nozzle (S/N 005) as the test vehicle are reported. The results of eight tests in which liquid hydrogen was admitted to the nozzle at pressures from 20 to 81 psig are given graphically in terms of coolant pressure, temperature, and flow rate and structure temperature for various axial and circumferential instrumentation stations. Five tests were made with the nozzle initially at ambient temperature and three at structural temperatures initially ranging from 860 to 1100°R. The results of one test (Run 003) are presented in considerable detail; representative data selected as typical of system response are shown for the balance of the test runs. (auth)

**21593** (RN-S-0350) OPERATING AND MAINTENANCE INSTRUCTIONS FOR XE-1 TEST STAND CONTROL SYSTEM

(TSCS), TEST SIMULATION SUBSYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1968. 412p. Dep. NTIS $23.75.

Detailed operating and maintenance instructions are provided for the Test Simulation Sub-System of the XE-Prime Test Stand Control System (TSCS). (LTN)

**21594** (RN-S-0366) HEAT-TRANSFER MARGIN TESTS FOR XE NOZZLE. Final Test Report. Wright, R. B. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1966. 97p. Dep. NTIS $8.00.

The results of chemical simulation testing of XE-configuration nozzle S/N 027 are presented. The primary purpose was to determine nozzle operating limits and to verify heat-transfer correlations. The limit was established by progressively increasing chamber pressure and then reducing coolant flow rates until tube erosion occurred. This test objective was achieved on the tenth test when six nozzle-throat tubes eroded at a chamber pressure of 801 psia, a mixture ratio of 5.7, and a coolant flow of 43.2 lb/sec. During the test series, injector erosion and combustion instability were noted on three tests. Predicted maximum tube-wall temperatures were found to be at least 100 degrees Fahrenheit lower than actual temperatures in the throat, 300 to 500 degrees Fahrenheit lower forward of the throat, and 500 degrees Fahrenheit higher at the exit plane of the nozzle. Recommendations are made concerning future chemical simulation testing of NERVA nozzles. (auth)

**21595** (RN-S-0367) NERVA RADIATION EFFECTS STATUS REPORT. Hart, W. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1967. 123p. Dep. NTIS $9.25.

The radiation-effects program provides technical support to NERVA relative to the materials, instrumentation, controls, and other component subtasks and performs radiation-effects tests as required. The results of the program have contributed to the development of components for the nuclear propulsion system. Transducers and components capable of performing in the nuclear-radiation environment of the technology engine have been developed, effects of neutron bombardment of structural materials have been established, and these data have been compiled to support future component instrumentation and structure designs. As engine size increases, continued study and testing are necessary to provide instruments and materials capable of withstanding more severe radiation environments. Recent modifications of two major test facilities (PBRF and General Dynamics) will enable greater flexibility in future radiation-effects tests at higher neutron flux and gamma levels. The Westinghouse test area, HT-1, in the Plumbrook reactor, has been made more versatile with the addition of a charging machine that enables insertion and withdrawal of test materials and components with the reactor operating at its full power of 60 MW. The HT-1 area is being further improved by the addition of facilities to enable irradiation testing at cryogenic temperatures. In support of the test effort, a library, the Radiation Effects Data Information File, has been established in the NRO Technical Information Center at Aerojet, Sacramento, and all radiation effects data obtained by Aerojet and Westinghouse are being catalogued and made readily available. (auth)

**21596** (RN-S-0374) OPERATING AND MAINTENANCE INSTRUCTIONS FOR XE-1 TEST STAND CONTROL SYSTEM (TSCS) SIGNAL CONDITIONING AND RECORDING SUBSYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1968. 164p. Dep. NTIS $11.25.

This operation and maintenance manual is intended to be used as an aid in determining interfaces, capabilities and operation, and maintenance of these equipments. Reference is made to the equipment manuals when applicable. The two principal functions of the TSCS Signal Conditioning System are to adapt and translate transducer variables into usable electrical signals for entry into the Process Control System and Engine Control System as feedback control parameters, and conditioning of signals for data system entry. The channel requirements are dictated by the transducer type (passive or active) and the control system feedback voltage requirements. In addition, signal conditioning is provided for those internally generated signals of the TSCS for entry into the data system. (auth)

**21597** (RN-S-0384) PHASE II OF THE COUNTERMEASURES RADIATION EFFECTS PROGRAM. Summary Report. Voreck, W. E.; Downs, M. E.; Lindberg, E. I. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1967. 97p. Dep. NTIS $8.00.

The work described is a continuation of the program initiated to investigate radiation effects on high explosives and propellants. Small-scale irradiations of 1.8- to 3.6-gram samples of candidate pseudostable materials, of small propellant strands, and of prototype exploding bridge wire (EBW) detonators were completed during Phase I. They resulted in the determination of the most radiation-stable materials for use as the main charge, booster and primary explosives, igniters, and propellants. In addition, a prototype detonator design was evaluated. The effects of radiation on the physical and chemical properties of the pseudo-stable materials were evaluated. Approximate exposure limits were established for the most radiation-stable materials. When NERVA flight-engine design has progressed to the point where specific countermeasures components are defined, large-scale testing of explosives, propellants, and detonators may be required. For this purpose, a containment capsule for the irradiation of high explosive in amounts to 80 grams has been developed. The large capsule will allow irradiation of propellant samples sufficiently large to accurately determine burning characteristics by use of a closed-bomb or high-pressure reactor. Detonator assemblies also will be irradiated in sufficiently large quantities for statistical analysis to be applied to post-irradiation tests. Engineering effort on this program stopped 31 March 1967. Phase II and later phases were cancelled since chemical explosive-destruct is not applicable to the 4180 MW version of the NERVA engine. This report summarizes work completed in Phase II and procedures applicable to radiation effects testing of ordnance components if they are required for countermeasures systems on the NERVA flight engine. (auth)

**21598** (RN-S-0386) ETS-1 SIDE SHIELD INVESTIGATIONS. Neal, P. E. (Aerojet-General Corp., Sacramento, Calif. (USA)). Mar 1967. 103p. Dep. NTIS $8.25.

To increase the reliability of the overall side-shield and Engine Test Compartment (ETC) system, Aerojet will conduct a test program relating to movement of the S-1 and S-2 side-shield cars and to radiation dosage levels. The proposed effort will include testing relative to cooling water flow; shield reliability; mechanical, seal, and leakage; removal operation qualifications; and an operational reliability study. The problems involve controlling flow to avoid overheating by the radiations, preventing overpressurization in case of certain malfunctions, protection of lines against freezing and reducing water usage, in addition to the problems of movability and seals. (auth)

**21599** (RN-S-0402) PRELIMINARY NERVA SKIRT DEVELOPMENT PLAN. Bronner, H. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 38p. Dep. NTIS $5.00.

The plan covers the design and development of a NERVA reactor skirt, NERVA engine skirt, NERVA engine skirt extension, and a NERVA engine skirt for system evaluation on Test Stand ETS-1 at NTO, Jackass Flats, Nevada. Design criteria, component descriptions, and test procedures for chemical-simulation testing are also included. Emphasis is placed on extensive analysis to arrive at the selection of a conservative design that will provide the component with the capability for a broad field of operation without violating prescribed margins of safety. Testing plays a secondary, but necessary, function by providing data to aid in verification of analysis, and by identifying areas where design refinements may be desirable. No attempt will be made to identify ultimate limits of operation through testing, only to verify that the normal band of operation is well within these limits, as described by the analysis. (auth)

**21600** (RN-S-0418(Bk. 1)) XE-PRIME TEST PREDICTIONS. Book 1. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1968. 200p. Dep. NTIS $13.00.

The XE-Prime engine will be the first nuclear powered engine system to be tested in the ETS-1 facility which permits a much closer approach to testing of a flight-type nuclear-powered system than was previously possible because: (1) the engine is located immediately below, and close-coupled to, the liquid-hydrogen supply tank; and (2) the engine will be fired downward in a simulated high-altitude environment. The engine characteristics under normal operating conditions are described. The results of the analysis of abnormal operation are presented in XE-Prime Malfunctions and XE Cooldown System Reports. Predictions of the operating characteristics of the XE-Prime engine, when tested in the ETS-1 facility have been prepared for use in test planning, test monitoring, and immediate posttest analysis. The objectives of the XE-Prime test series can be divided into two main categories: (1) determination of engine operating-characteristics and establishment of a technical basis for development of engine control for future engine systems; and (2) evaluation of engine and test stand components in a nuclear environment and the development of engine operational procedures for flight. (auth)

**21601** (RN-S-0421) PRELIMINARY NERVA NOZZLE DEVELOPMENT PLAN. Wright, R. B. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 38p. Dep. NTIS $5.00.

The NERVA Nozzle Development Plan is a requirement of the CY 1967 work statement. In addition to hydrostatic tests, the plan covers a series of chemical tests for hot-bleed-port selection, hot-bleed-port design verification, and nozzle design veri-

fication. Descriptions of the various test components, test requirements, and test procedures are included. (auth)

**21602** (RN-S-0425) QUALIFICATION TEST PLAN, BENDIX MODEL NT-D1 TURBINE POWER CONTROL VALVE ACTUATOR. Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 46p. Dep. NTIS $5.50.

Qualification testing plans for the Bendix turbine power control valve (TPCV) actuation system, Bendix P/L 2775030, Model NT-D1, are described. The plan defines the general and detailed requirements that apply to all tests and test report documentation. The Actuator Qualification Test Plan includes proof pressure, vibration, mechanical shock, humidity, and life tests. (auth)

**21603** (RN-S-0427) XE DATA ANALYSIS PROGRAM. Slonim, N. H.; Strucel, G. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 184p. Dep. NTIS $12.25.

The first phase of a narrow-band data analysis computer program developed by Aerojet-General Corporation for handling test data in the NERVA program is described. The program is written in FORTRAN IV language for processing on the IBM 360-65 computers. Capabilities of the program include the preparation of multiple plots of test data, the performance of engineering calculations such as for flow rate and thermal power, the smoothing of data to minimize the noise from the data for purposes of evaluation, the preparation of steady-state summaries of selected time slices for component and system evaluation, the listing of measurement anomalies to identify missing or offscale data and to pinpoint bad data recordings, and the listing of events for the evaluation of test-system performance. Descriptions covering input to, and output from, the program are given in detail. (auth)

**21604** (RN-S-0430) BENDIX MODEL NT-D1 TURBINE POWER CONTROL VALVE ACTUATOR QUALIFICATION TESTING. Summary Report. Harris, W. P.; Krauter, K. E.; Suttkus, H. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1968. 369p. Dep. NTIS $21.50.

Several individual tests are reported which are a part of the Bendix Model NT-D1 Turbine Power Control Valve (TPCV) actuator qualification program. The program consists of vibration, proof, humidity, shock, and endurance tests on the actuator alone; high-temperature-hydrogen-flow testing of the actuator-valve assembly; and the use of the actuator-valve assembly for turbine power control during an actual hot-firing test of the complete engine system. The results demonstrate the qualification of the NT-D1 actuator for use in the Experimental Engine program. This test program generated recommendations for (1) improvement of the NT-D2 and any subsequent actuators; (2) additional testing to be performed on the NT-D2 actuators; (3) upgrading the actuator performance criteria for future procurements. Recommended hardware improvements include: (1) the possible addition of a mechanical feedback between first and second stages of the servovalve for improvement of performance in certain vibration environments; (2) increase in actuator output torque; (3) the improvement of current transmission gear tooth geometry; (4) improvement of servovalve discharge line bellows installation; and (5) the possible reduction of ullage between the actuator servovalve and gear motor (resulting in a "stiffer" system). The recommended additional testing generally consists of breadboard tests of the hardware improvements noted above. Updating of the performance criteria would consist mainly of (1) basing the actuator performance criteria on loaded dynamic conditions, and (2) specifying the actuator performance requirements in terms of its open loop characteristics. (auth)

**21605** (RN-S-0432) TRANSIENT-ENGINE-SIMULATION PROGRAM (FORTRAN IV). Wells, R. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1967. 264p. Dep. NTIS $16.25.

A finite-difference, explicit-solution, digital-computer program is described that calculates solid temperature, liquid temperature, and pressure distribution as functions of distance and time throughout the NERVA engine system. The program is coded in FORTRAN IV for use with the third-generation IBM 360-65 computer. The development of equations and the logic used in their solution are presented. (auth)

**21606** (RN-S-0433) EVALUATION OF DATA FROM ETS-1 FACILITY AND NES-DUCT CHECKOUT TESTS. Kasahara, M.; Miller, J. D.; Misra, B.; Ottaviani, A. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1967. 181p. Dep. NTIS $22.25.

Data analyses of the ETS-1 facility checkout tests (FEP-I through -IV) and the nuclear-exhaust-system (NES) Phase-I and Phase-II NEPN-1 tests are reported. The analyses were performed to further evaluate the facility and NES system performances and to upgrade the computer models for the engine cooldown predictions. Data from the NES tests were analyzed to evaluate duct and steam-generator performances, simulated malfunction shutdowns, and various methods of preventing air backflow into the duct that could occur during certain modes of malfunction shutdowns. Flow resistances and dynamic response in the liquid-hydrogen cooldown system were checked out. Flow resistances in the various facility purge and cooldown lines were determined to upgrade the computer models for the engine cooldown predictions. (auth)

**21607** (RN-S-0434) PRELIMINARY DESIGN CRITERIA FOR NERVA NOZZLE ASSEMBLY. Watkins, J. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 13p. Dep. NTIS $4.00.

The requirements and criteria for a regeneratively-cooled nozzle assembly for the NERVA reactor and engine assembly are defined. Also included are the design requirements for the bleed-port assemblies, which are part of the nozzle assembly. The nozzle assembly terminates at the nozzle station where the area ratio is 4:1 and, therefore does not include the skirt assembly. The primary function of the nozzle assembly is to accelerate the reactor effluent gas to impart maximum thrust and impulse to the NERVA engine. Secondary functions include: Conducting hydrogen fuel from the pump discharge line to the reflector inlet, serving as an aft closure for the pressure-vessel/reactor assembly, extraction of turbine drive gas from the chamber (which is cooled on passing through the bleed-port assembly), provision for attaching the aft-skirt assembly, provision of a cylindrical section to support the reactor assembly, and attachment points for engine control and diagnostic instrumentation. The NERVA nozzle will be similar to the NERVA-technology and Phoebus nozzles. The tube wall thickness will be selected to minimize stress and temperature consistent with nozzle operating constraints and with the applied safety factors as defined. (auth)

**21608** (RN-S-0438) NERVA RADIATION EFFECTS STATUS REPORT (PRELIMINARY). (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1967. 136p. Dep. NTIS $10.00.

The radiation-effects program provides technical support to NERVA relative to the materials, instrumentation, controls, and other component subtasks and performs radiation-effects tests as required. This report summarizes the expected operational environments of materials and transducers, defines problem areas associated with designing for the NERVA environments, and presents a radiation test history of the engine components and materials development program through September 1967. The results of the radiation-effects program have contributed to the development of components for the nuclear propulsion system. Transducers and components capable of performing in the nuclear-radiation environment of the technology engine have been developed, effects of neutron bombardment of structural materials have been established, and these data have been compiled to support future component instrumentation and structure designs. A review of program accomplishments, a discussion of work in progress at CY 1967 year-end and an outline for a continuing radiation-effects program are presented. (auth)

**21609** (RN-S-0444A) INFLUENCE OF SPACE ENVIRONMENT ON NERVA ENGINE DESIGN. Second Report. Lamvermeyer, D. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1967. 48p. Dep. NTIS $5.50.

The effect of the space environment on the operation of the NERVA engine system and components is evaluated. The evaluation, based upon the environmental factors associated with the large flight-weight engine configuration, may require modification for new missions and engine configurations. Previous studies that have emphasized environment definition, vacuum effects, and the results of the Syracuse adhesion experiment are employed toward evaluation of the NERVA engine system during an interplanetary mission. Problem areas that need to be solved include: (1) definition of the environment; (2) analysis of pressure data during the mission; (3) contribution of adhesion and its mechanisms to a malfunction; and (4) application of design approaches to mitigate the influence of space environment. A program plan has been prepared to define an approach for experimental evaluation of the potential problems that will be encountered. A proposed matrix of the parameters to be investigated, as well as an estimated test schedule, has also been included. (auth)

**21610** (RN-S-0446) PREDICTED MEASUREMENT UNCERTAINTIES, NRX-A6. Kneeland, D. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1967. 66p. Dep. NTIS $6.50.

Uncertainty curves that define the ±3 sigma uncertainty band associated with each point in the measurement range for each parameter are provided. Uncertainties attributable to the transducers and those attributable to the data recording and reduction system have been evaluated independently and are plotted sepa-

rately to demonstrate the relative contributions. The total measurement uncertainty is also plotted and was obtained by assuming that the transducer and data system uncertainties are random and can be combined through the square root of the sum-of-the-squares (RSS) technique. (auth)

**21611** (RN-S-0450(Vol.2)) HANDBOOK OF OPERATING AND MAINTENANCE INSTRUCTIONS FOR XE-1 ENGINE CONTROL SYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1968. 386p. Dep. NTIS $22.50.

A handbook is provided as a current source of maintenance and checkout information concerning the XE-1 Engine Control System (ECS). The ECS is discussed in general and the ECS chassis for which AGC and Westinghouse had the design, development, and manufacturing responsibility are discussed in detail. A complete cross reference to all ECS chassis by rack and console number to AGC O&M handbooks is included. (auth)

**21612** (RN-S-0456) PREDICTED MEASUREMENT UNCERTAINTIES, XECF. Kneeland, D. G. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1968. 69p. Dep. NTIS $6.50.

Uncertainty values that define the ±3 sigma uncertainty band associated with each point in the measurement range for the listed parameters of the XECF test are provided. Uncertainties attributable to the transducers and those attributable to the data-recording and -reduction system have been evaluated independently and are shown separately to demonstrate the relative contributions. The total measurement uncertainty is also indicated and was obtained by assuming that the transducer and data-system uncertainties are random and can be combined through the square-root-of-the-sum-of-the-squares (RSS) technique. (auth)

**21613** (RN-S-0457) EVALUATION OF NRX-A6 PRESSURE VESSEL ASSEMBLY. Tracy, D. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1968. 17p. Dep. NTIS $4.00.

An evaluation of the performance and integrity of the NRX-A6 pressure vessel assembly is presented. The pressure vessel assembly consisted of pressure vessel cylinder (S/N 880012), pressure vessel closure (S/N 880012), nozzle/cylinder seal (S/N 000057), cylinder/closure seal (S/N 880252), closure bolts and closure bolt seals. No anomalies in pressure vessel performance were detected during the extended nuclear test. The ability of the assembly to withstand all environmental loading and function satisfactorily was again demonstrated. (auth)

**21614** (RN-S-0460) FINAL REPORT ON NUCLEAR-EXHAUST-SYSTEM (NES) DEVELOPMENT PROGRAM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1968. 58p. Dep. NTIS $6.00.

The nuclear exhaust system (NES) installed on ETS-1 comprises two major subsystems—an exhaust duct and the steam generator system (SGS) interconnected by the steam pipes. The exhaust duct interfaces with the engine test compartment (ETC) and (1) directs the engine exhaust gases down and away from the ETC and (2) provides altitude simulation within the ETC by the aerodynamic pumping action of the engine exhaust gases. The SGS produces steam that is injected into the exhaust duct through downstream-oriented nozzles. The steam acts on the duct (1) as an ejector to reduce the pressure in the ETC and provide a limited degree of altitude simulation during engine startup and (2) as an aerodynamic check valve to prevent air backflow into the duct if primary flow should suddenly terminate. Tests performed between November 1966 and June 1967 included: Duct coolant-water system-flow balancing tests, tests to verify results of the Steam Generator System (SGS) improvement program, flow tests of the duct with cold gas used to simulate engine exhaust gas, and tests to verify the prevention of air intrusion into the engine test compartment (ETC) during SGS simulated malfunctions. The test results are described in detail. (auth)

**21615** (RN-S-0462) NRX-A6 POSTTEST INSTRUMENTATION REPORT. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1968. 45p. Dep. NTIS $5.25.

NRX-A6 temperature, pressure, strain, and vibration parameters were monitored by means of 90 measurements, of which 51, classified as diagnostic, were made solely to supply data with which to evaluate test-article performance. The remaining 39 measurements, classified as evaluation type, were accomplished with new transducer designs and new installation techniques, or were used to monitor environments in the vicinity of new transducer designs. Sixteen anomalies were noted in the diagnostic measurements, and twelve were noted in the evaluation measurements. (auth)

**21616** (RN-S-0468) POSTTEST ANALYSIS OF NRX-A6 EVALUATION RTTs ROSEMOUNT MODEL NO. 134JA-1. Sita, E. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1968. 29p. Dep. NTIS $4.50.

Six Rosemount Model 134JA-1 (AGC PN 1116474) redesigned platinum resistance-temperature transducers (RTTs) were evaluated in the propellant feed system of the NRX-A6 engine that was tested in December 1967 for one hour at full power. The general purpose of the test was to determine the suitability of the redesigned RTT for use in the XE series engines. Specific test objectives were: to qualitatively determine the performance of the redesigned transducers during full-power engine operation; to correlate the performance of the RTT in the engine environment with the results of previous radiation damage studies; and to qualify the redesigned RTT for diagnostic use on the XE series engine. Data resolution was improved significantly by the use of narrow ranged channels that enabled the detection of small temperature variations caused by system performance and gamma- and neutron-induced errors. The redesigned RTTs are qualified for use in the X-Engine environment based on the performance of the transducers in similar X-Engine parameter locations on NRX-A6. There are some reservations with respect to gamma heating errors correction and radiation effects, which are dependent on engine radiation and temperature conditions. (auth)

**21617** (RN-S-0469) E-1 COMMON ANALOG MODEL. Revision 5. (Aerojet-General Corp., Sacramento, Calif. (USA)). 26 Aug 1970. 63p. Dep. NTIS $6.25.

Revised equations and other information are presented for the E-1 common analog model. (LTN)

**21618** (RN-S-0470) CORRELATION STUDY OF ULTRASONIC SHEAR-WAVE INSPECTION OF NOZZLE COOLANT-CHANNEL BRAZE SHEAR-JOINTS PHOEBUS-2 NOZZLE S/N 880600. Peterson, R. M. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1968. 49p. Dep. NTIS $5.50.

A correlation study of the ultrasonic shear-wave inspection of nozzle coolant-channel brazed shear-joints is described. The tooling requirements, test setup, and technical data obtained are also described. Results show a direct correlation of ultrasonic-signal amplitude to the measured amount of unbraze. A computer analysis of the data is also presented. It is recommended that additional data be obtained from a nozzle that has machined grooves for comparison with data obtained from grooves made by the electrical discharge machining method. The data would then be evaluated to further establish the confidence level of the ultrasonic shear-wave technique. A decision could then be reached whether to proceed with a quantitative, computerized system for the ultrasonic inspection of future NERVA nozzle coolant-channel braze shear-joints. (auth)

**21619** (RN-S-0483) MATERIALS AND PROCESSES PLAN FOR THE NERVA ENGINE SYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1968. 23p. Dep. NTIS $4.25.

**21620** (RN-S-0488) E AND R SYSTEM ANALYSIS. Stiger, R. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1968. 221p. Dep. NTIS $14.25.

A status report for the systems analysis of engine and reactor systems is presented. These studies were performed in support of the NERVA engine task force to establish the design requirements baseline. (auth)

**21621** (RN-S-0492) XE COOLDOWN SYSTEMS. Stewart, J. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1968. 375p. Dep. NTIS $21.75.

The XE Cooldown Systems Report are described, including the high pressure $LH_2$, GHe, $GH_2$, and $LN_2$ cooldown systems and their operation. Supporting systems, such as the engine safety system, pneumatic and hydraulic actuation systems, electrical power system, and instrumentation system, are also discussed. Particular emphasis is given to steps that were taken to increase the overall system reliability. The results of analog and digital computer analyses used for the design of the systems are presented. In addition, the results of demonstration tests performed with the cooldown systems are discussed. The results of cooldown system malfunction studies are also presented. On the basis of the combined results of the demonstration tests and computer analyses, the cooldown systems are considered adequate for use in XE testing. (auth)

**21622** (RN-S-0522) DEVELOPMENT OF FLUIDIC SUBSYSTEM FOR NERVA-ENGINE CHAMBER-PRESSURE CONTROL. Annual Progress Report. Carroll, J. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1969. 185p. Dep. NTIS $7.25.

**21623** (RN-S-0526) NERVA REFERENCE DATA. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1969. 137p. Dep. NTIS $10.00.

NERVA-engine operational and performance data are summarized with design characteristics, and necessary design considerations and support-related activities. It provides a

quick, common source of data for all users. General information has been included to permit a better understanding of the overall NERVA program. The NERVA-engine reference design was developed to satisfy the requirements established by SNPO-NPRD-1, NERVA Program Requirements Document. Missions defined by SNPO-NPRD-1 have been analyzed to identify additional NERVA-engine requirements. Mission-related engine requirements will require periodic revision to incorporate the results of stage and vehicle inputs. (auth)

**21624** (RN-S-0533) REFERENCE MISSION DATA BOOK FOR NERVA DESIGN. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1969. 247p. Dep. NTIS $15.50.

NERVA Engine (hot-bleed type) design requirements are provided and data about proposed mission requirement from which engine requirements can be generated are presented. (LTN)

**21625** (RN-S-0539) PRELIMINARY IMPLEMENTATION PLAN FOR NERVA TREND DATA PROGRAM. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Oct 1969. 30p. Dep. NTIS $4.50.

The purpose of the Trend Data Program is to identify and monitor selected critical characteristics of the NERVA engine system, subsystems and components (nuclear and non-nuclear) as a means of detecting trends which might indicate an adverse effect on the reliability of the NERVA engine system. Such characteristics are called Trend Characteristics (TCs) which, when analyzed for trends, indicate changes such as deterioration, wear, or changes in critical processes or procedures. The changes of interest in this program are those which would indicate adverse changes in performance. The TCs can therefore be thought of as reliability indicators. The purpose of identifying and monitoring TCs is to obtain information which will be useful in determining the point where action must be taken to avoid incipient failure of the reactor or engine during ground or flight tests and to establish TC monitoring requirements necessary to assure achievement of system reliability goals. The monitoring of these TCs will be conducted through all phases of the NERVA Program–development, qualification and production of deliverable hardware. (auth)

**21626** (RN-S-0541) FINAL REPORT, CY 1969. Shielding Code Development Program, Project 393. Lindstrom, D. G.; Koebberling, K. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). Feb 1970. 65p. Dep. NTIS $6.25.

Improved shielding and radiation analysis computer codes are described. DASH was developed to accept leakage angular flux data from the discrete ordinates code, DOT and serve as a bridging code as follows: This flux information can be used to trace particle histories in space and be used as source information for Monte Carlo calculations or other DOT calculations. Since DASH takes DOT output and puts it in Monte Carlo format, a very powerful tool is thus made available, wherein the DOT code can be used where it offers the best solution and Monte Carlo codes can be used where they perform best, without the requirement of starting out as a Monte Carlo analysis (e.g., from the fission events in a reactor problem). A number of neutron cross-section handling codes were also developed. The geometry routine of the FASTER Monte Carlo code was incorporated into the FMC-G and FMC-N Monte Carlo codes and the QAD and GGG point kernel codes, to minimize the setup time required for use of more than one code for the same geometrical model. (auth)

**21627** (RN-TD-0043) FINAL REPORT OF XE FOUR-INCH INTERNALLY GIMBALLED BELLOWS ASSEMBLY RANDOM VIBRATION TEST. Tracy, D. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). 12 Mar 1969. 59p. Dep. NTIS $6.00.

The objective of demonstrating the structural integrity of the turbine inlet line four-inch internally gimballed bellows (P/N 1114005-5) subjected to a random vibration environment equivalent to 70 minutes of XE-Prime testing was accomplished. Although the equivalent test time in the tangential direction was below the planned criterion, an evaluation of all test data and test events leads to the conclusion that a valid demonstration test was conducted. The structural integrity of the three bellows was demonstrated by their withstanding a vibration environment more severe than that they will experience during the 70-minute engine test. As good physical simulation of the upper turbine inlet line was achieved in the test article, it can be concluded that the dynamic capabilities of the entire line assembly were demonstrated. Since the only failures encountered during testing were two in the bellows assembly end-tube, it also can be concluded that for dynamic loading this is the weakest link of the upper turbine inlet line assembly. (auth)

**21628** (RN-TM-0155(Vol. 4)) NERVA TURBOPUMP MARK III MOD 4 IMPELLER VANE NATURAL FREQUENCY TEST REPORT. Harris, C. L. (Aerojet-General Corp., Sacramento, Calif. (USA)). 25 Aug 1965. 14p. Dep. NTIS $4.00.

A vibration test to establish the natural frequencies of the impeller vanes was performed on the NERVA Mark III Mod 4 centrifugal pump impeller. The first and second resonant frequencies occurred at 1106 and 1344 Hg for the full vane. All impeller vanes of the same type resonated at the same frequency. Vane deflections at resonance and resonance bandwidths were also measured. (LTN)

**21629** (RN-TM-0159) BASIC LOADS AND STRUCTURAL DESIGN CRITERIA FOR THE XE-1 ENGINE. Lucier, J. R.; Talbott, K. E. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 14p. Dep. NTIS $4.00.

Loads acting on the XE-1 engine are divided into primary and secondary loads for the purpose of defining their importance. Primary loads are those caused by inertia, pressure and thrust, while secondary loads are those which might occur from an unusual source such as a sudden jolt on the EIV or a break in the propellant line at the nozzle, which would produce a side thrust on the engine. Secondary loads may combine with primary loads to produce a maximum expected loading condition on the engine. In addition to the above, the effects of vibration and temperature are considered as secondary loads. Methods of determining combined loads from formulae, calculations, specifications, design thrusts, etc. are given. The relation between limit loads and design loads is given. (auth)

**21630** (RN-TM-0217) STRUCTURAL ANALYSIS AND NON-NUCLEAR COMPONENTS FOR NRX/EST ENGINE SYSTEM. Part 1 (Summary). (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1965. 23p. Dep. NTIS $4.25.

Mechanical stresses resulting from basic loads (T. M. 0145), system pressures (AGC Specification 90013) and thermal stresses have been calculated for AGC-designed components for NRX/EST, and compared to yield or ultimate material strengths, to estimate a margin of safety for the items. (LTN)

**21631** (RN-TM-0220) DIGITAL COMPUTER PROGRAM FOR ROCKET REACTOR TRANSIENT SIMULATION. Seawell, O. D. (Aerojet-General Corp., Sacramento, Calif. (USA)). 25 Jun 1965. 198p. Dep. NTIS $13.00.

The OSCAG, digital-computer, reactor-kinetics program was developed for use in nuclear-rocket-transient simulation. Its two variations are designated as OSCAG 1 and 2. The program is designed for the solution of a wide variety of problems involving the interrelationships of many neutronic and thermal parameters. It may be used independently in analyzing a reactor that is uncooled or has constant power removal to coolant. In conjunction with an engine-analysis program, it can provide transient simulation for the cooled nuclear-rocket engine. One combination of this type has been developed that employs OSCAG 2 and the FLOW program of subroutines; this combination is designated as AGTRAN. (auth)

**21632** (RN-TM-0227) UPPER THRUST STRUCTURE S/N0000009 STRUCTURAL TEST EVALUATION. Thomas, R. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). 23 Jul 1965. 70p. Dep. NTIS $6.50.

A structural test series was successfully conducted on a modified XE-1 type NERVA Upper Thrust Structure (UTS) for the Cold Flow Development Test (CFDTS) Program at the Aeronca Manufacturing Corporation, Torrance, California during December, 1964. The testing consisted of singularly applying tension and compression, axial and shear static loads to the UTS assembly and axial tension and shear loads to the pump support panel sub-assembly. Based on strain and dial indicator data, the UTS successfully demonstrated structural integrity for CFDTS load conditions. Considerable information was obtained for X-engine design. (auth)

**21633** (RN-TM-0331) STRESS ANALYSIS OF UPPER THRUST STRUCTURE XE-1. Soo, P. P. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 122p. Dep. NTIS $9.25.

The NERVA XE upper thrust structure is a fuselage-type semi-monocoque structure which primarily consists of 12 equally-spaced longitudinal stringers, 6 nearly equally-spaced transverse bulkheads, and a thin-sheet covering shell having a nominal diameter and depth of 100 and 95 inches respectively. This structure is attached to the test stand adapter through 12 lugs at one end, and to the external shield at the lower end. The primary load imposed on this structural system are the inertia loads in both longitudinal and transverse directions, and the structural vibration loads due to the nozzle and the turbopump during operation. The resulting stresses and deflection levels on the structural components of the NERVA XE upper thrust structure have been calculated. A summary of preliminary results, method of analysis, technical discussion, conclusions and recommendations are included. (auth)

**21634** (RN-TM-0332) STRESS ANALYSIS OF THE XE-1 LOWER THRUST STRUCTURE. Jellison, J. E. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jul 1966. 18p. Dep. NTIS $4.00.

The stress analysis of the Lower Thrust Structure consisted primarily of an investigation (1) of the buckling characteristics of the stiffeners and skin sections to determine the level of stability of the cone as a composite structure, (2) the ability of the attachment lugs at the shield and pressure vessel interfaces to resist the design thrust and inertia loads without permanent deformation and (3) the margins of safety in the fasteners. During engine operation the Lower Thrust Structure will be exposed to a high gamma flux which will raise the temperature of the structure above the permissible limit for aluminium. It was necessary, for this reason, to use titanium, which offered the best strength-density ratio at the maximum temperatures involved. It was concluded that all components are structurally adequate to sustain the design loading conditions with the required margins of safety. (auth)

**21635** (RN-TM-0351) SUMMARY OF ANALYSES OF THE NON NUCLEAR STRUCTURAL COMPONENTS FOR THE XE-1 TECHNOLOGY ENGINE. Lucier, J. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). Sep 1966. 70p. Dep. NTIS $6.50.

The XE-1 Engine System consists of the following non-nuclear subsystems: thrust chamber assembly (TCA), propellant feed system (PFS), controls system, and instrumentation system. The first two subsystems are of primary interest to the stress analyst. The controls and instrumentation systems require some review but extensive analysis. All of the primary thrust chamber assembly components and propellant feed system components listed were subjected to stress analysis. The thrust chamber assembly components, which make up the principal engine structure, were subjected to a combined loading condition consisting of thrust and inertia loads which act to produce shear, moments, and axial forces of varying magnitude along the engine length. The resulting stresses and strains are calculated and compared to material strengths for the purpose of estimating the margins of safety in the structure. In addition to the thrust and inertia loads, the propellant feed system components and the PVARA were subjected to pressure, temperature, and vibration loads produced by the system environment. (auth)

**21636** (RN-TM-0359) NRX-A5 ALUMINUM PRESSURE VESSEL, S/N 0000010. Structural Evaluation of Redesigned Cylinder/Closure Joint. White, D. E. (Aerojet-General Corp., Sacramento, Calif. (USA)). 29 Jun 1966. 32p. Dep. NTIS $4.75.

A standard 740 psig hydrostatic proof and acceptance test of the NRX-A5 aluminum pressure vessel, S/N 0000010, was conducted at the Marquardt Corporation, Ogden, Utah, from 1 February through 4 February 1966. In conjunction with the standard test, strain gages and deflection instruments were installed. Metallic seal P/N 286770 was installed for the helium leak test portion of the acceptance procedure. The instrumentation and metallic seal were used to verify the adequacy of the forward closure joint redesign. This vessel was the first unit to incorporate a smooth transition from shell to joint. This test successfully demonstrated that the modification of the forward cylinder and closure flanges improved the compatibility of the forward pressure vessel joint. The adequacy of the new design is shown by the reduction in meridional stress, the decrease in differential rotation of the flanges and lack of detectable helium leakage at 500 psig. (auth)

**21637** (RN-TM-0372) EVALUATION OF NRX/EST PRESSURE VESSEL. Tracy, D. W. (Aerojet-General Corp., Sacramento, Calif. (USA)). 23 Nov 1966. 24p. Dep. NTIS $4.25.

An evaluation of the performance and integrity of the NRX/EST pressure vessel assembly is presented. The pressure vessel assembly consisted of pressure vessel cylinder S/N 007, pressure vessel closure S/N 008, nozzle/cylinder seal S/N 0000107, cylinder/closure seal S/N 0000103, 120 closure bolts and 120 closure bolt seals. The pressure vessel again successfully demonstrated its ability to withstand all pressure and environmental loading and to function satisfactorily during an extended-duration nuclear test. No major abnormalities in pressure vessel performance were detected. (auth)

**21638** (RN-TM-0412) HOT BLEED-PORT NOZZLE-PRESSURE VESSEL STRUCTURAL TEST. White, D. (Aerojet-General Corp., Sacramento, Calif. (USA)). [nd]. 162p. Dep. NTIS $11.25.

The Hot Bleed Port Nozzle-Pressure Vessel Structural Test (Test 1343N) was successfully conducted. The test item utilized an aluminum alloy development pressure vessel, S/N 0000003, and AGC Steel Nozzle S/N 008, which incorporates a hot bleed port. The test objectives were to (1) evaluate the Hot Bleed Port Nozzle-Pressure Vessel compatibility at an ambient pressure vessel proof pressure of 740 psig, and a nozzle chamber pressure of 560 psig; (2) measure deflections and rotations of the nozzle hot bleed port; (3) evaluate the Hot Bleed Port Nozzle-Pressure Vessel Assembly, and; (4) record strains at critical areas. The measured deflections, rotations, and strains were all within the experimental limits of the theoretical predictions. The pressure vessel ruptured at 1380 psig (versus a theoretical rupture pressure of 1370 psig) thus demonstrating a safety margin of .87, as related to the ambient proof pressure of 740 psig. The apparent bi-axial gain was 14.2% for this aluminum alloy pressure vessel. For this specific test, the stress concentration factor was 1.23 for the two 0.5-in. instrumentation passthrough holes with a center-to-center spacing of 2 in. This hole location proved to be the point of failure. (auth)

**21639** (RN-TM-0418) DEVELOPMENT OF THE FLAME-SPRAYED ALUMINUM CONCEPT FOR CONDUCTIVE COOLING OF XE ENGINE-MOUNTED ELECTRICAL CABLES. Sita, E. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). 26 Jan 1967. 37p. Dep. NTIS $5.00.

**21640** (RN-TM-0427) WIDE-BAND DATA-PROCESSING AND ANALYSIS CAPABILITY. Benenson, H. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jun 1967. 40p. Dep. NTIS $5.00.

The Aerojet analysis facilities have been developed over many years to support liquid-rocket, solid-rocket, and other testing activities and now represent an extensive and highly flexible capability in terms of equipment, experienced operating personnel, and management direction. The facilities, equipment, and related programs and procedures have been primarily financed by other programs, but are available to the NERVA program. The ultimate purpose of wide-band data analysis is to support the systems-evaluation requirements of the NERVA engine. To achieve this purpose, all variables that can influence the test data must be accounted for and be fully understood so the data can be properly interpreted. The wide-band data-processing system is described in detail to show the present Aerojet capability, and some of the equipment and analytical programs are described. (auth)

**21641** (RN-TM-0429) BALL VS. POPPET VALVE COMPARISON FOR THE NERVA PROPELLANT SHUTOFF VALVE (PSOV) APPLICATION. Lundback, A. V. (Aerojet-General Corp., Sacramento, Calif. (USA)). 12 Apr 1967. 26p. Dep. NTIS $4.50.

The basic function of the Propellant Shut Off Valve (PSOV) is to: (1) provide shutoff capability of propellant flow from the stage tank and (2) minimize disturbance of the propellant flow into the pump inducer. Two valve concepts have been investigated; (1) the poppet design, and (2) the ball design. The capabilities of both units are compared with the design requirements and the relative advantages and disadvantages of each design are discussed. The poppet type PSOV design has been selected for use because it will provide the following advantages: shorter length, lower and more uniform fluid acceleration, lower internal leakage with less complexity, more uniform distribution of pressure-area force through the valve body, lower thermal distortion, higher potential reliability, structural distortion is more predictable, easier fabrication and lower predicted cost. (auth)

**21642** (RN-TM-0435) COOLANT PRESSURE DROP AND ENTHALPY RISE EQUATIONS FOR THE PHOEBUS-2 NOZZLE. Sane, J. O. (Aerojet-General Corp., Sacramento, Calif. (USA)). 26 Apr 1967. 59p. Dep. NTIS $6.00.

Closed-form equations for the coolant pressure drop and coolant enthalpy rise through the Phoebus-2 nozzle were desired by the Los Alamos Scientific Laboratory for incorporation into an analytical model of the Phoebus-2 system. These equations have been derived over the range of conditions anticipated for start-up, shut-down, full power and intermediate hold points. The two distinct regimes considered were full nozzle flow with supercritical coolant and separated nozzle flow with supercritical coolant. (auth)

**21643** (RN-TM-0551) NERVA PNEUMATIC SUPPLY SYSTEM DESIGN REPORT. Williams, S. J. (Aerojet-General Corp., Sacramento, Calif. (USA)). 2 Oct 1967. 42p. Dep. NTIS $5.25.

The pneumatic systems for NERVA required (1) to operate the engine actuators during the startup transient and (2) to prepressurize the main propellant tank ullage are discussed. The latter is needed to start the turbopump. It is concluded that these systems should be separate. Further information is needed about gas required for startup, restart, purge requirements, etc. before the design of the penumatic system can be finalized. (LTN)

**21644** (RN-TM-0584) SHIELDING TRADE STUDY INTERIM STATUS REPORT. Koebberling, K. O.; Rogers, D. R.; Lindsey, B. A.; Courtney, J. C. (Aerojet-General Corp., Sacramento, Calif. (USA)). May 1969. 100p. Dep. NTIS $8.00.

As a result of the trade study of the shielding requirements for manned NERVA flights, the primary candidate shield configura-

tions are: engine disk shielding, engine brim and variable internal shielding, and capsule (payload) shielding. Either of the engine shield configurations could be used in conjunction with capsule shielding. However, sufficient data are not available to allow a reasonable statement of weight requirements if all or most of the shield weight is at the capsule. That is to say, the engine shields have been studied in detail with methods which are not much different than the more sophisticated Monte Carlo analytical technique as long as the shield is at the source. Only straight exponential curves are available for the capsule shields and the less sophisticated techniques do not apply when one is trying to shield the detector (i.e., the crew) locally. (auth)

**21645** (RN-TM-0592) EXPERIMENTAL STUDY OF THE NOISE FIELD RESULTING FROM GROUND TESTING A NUCLEAR ROCKET ENGINE. Fairall, R. S.; Thompson, W. R. (Aerojet-General Corp., Sacramento, Calif. (USA)). 20 Oct 1969. 66p. Dep. NTIS $6.50.

The ground-test facility for the nuclear rocket requires an engine test compartment (ETC) that will enclose the engine and a nuclear exhaust system (NES) to convey the heated hydrogen propellant (primary fluid) away from the engine and ETS-1. Typically, the ETC is purged with a small amount of nitrogen gas. Further purging and a low nozzle back pressure are provided by introducing a large flow of high-temperature steam (secondary fluid) into the NES. The resulting mixture of gases burns along the surface of the plume at a rate that is controlled by the diffusion of ambient oxygen into the hydrogen-rich jet. Since posttest inspection of ETS-1 after XECF tests showed evidence of damage caused by acoustic forces, it was apparent that the jet noise anticipated during later high-power engine tests could reach destructive levels. A comprehensive investigation of the noise field was undertaken and the acoustic measurements taken are reported here. All acoustic data collected were processed for spectral evaluation. There is a low frequency contribution that appears to result from the combustion process. Jet conversion efficiency, limits of combustion, and frequency-spectra results are reported. Oscillatory combustion was considered possible, but no evidence of its occurrence was obtained. The spectral shape is similar to the jet-noise spectra for rockets and turbojet engines as reported in published literature. The measured-sound pressure levels for the duct-vault inerting wall and the weather doors at ETS-1 agree quite well with the calculated values; the actual levels are about 1 db lower than those that were predicted. The tabulated results of the measurements, a sketch of the duct model and test stand, a photograph of the exhaust plume, schematics of the data-processing system, spectral-density profiles, and the relation of sound to mechanical power are included. Statistical analysis of the acoustic power shows that the variation in acoustic efficiency is reduced if a thermal-mechanical theoretical model is utilized rather than the conventional theoretical model of a noise-radiating jet. (auth)

**21646** (RN-TM-0597) PRELIMINARY NUCLEAR DESIGN OF EXTERNAL DISK SHIELD. Rogers, D. R.; Warman, E. A. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1970. 30p. Dep. NTIS $4.50.

The Shielding Trade Study, completed in December 1969 resulted in the selection of an uncooled disk shield external to the pressure vessel as the best means of providing biological shielding to limit the radiation environment of the crew. The size and weight of disk shield required depends on the requirements of the mission. Engine design provides for disk shielding weighing up to 10,000 lbs. A disk shield as heavy as this is required only for missions with very light payloads, while little or no disk shield may be required for missions with heavy payloads. A preliminary nuclear design of a nominal 10,000 lb disk shield is provided and consists of a lead disk shield and a back-up borated steel disk shield with 2 inches of borated graphite between the source and the shield to absorb low energy neutrons in soft gamma-emitting $(n,\alpha)$ reactions with boron on the source side of the gamma shielding. (auth)

**21647** (TID/SNA-1) NERVA ENGINE SHIELD PENETRATION DESIGN STUDY. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Sep 1970. 42p. Dep. NTIS $5.25.

This design study was conducted to investigate the feasibility of routing the engine turbine lines directly between the pressure vessel and the turbopumps with penetrations in the external shield. A possible improvement in engine design was weighed against the complexity and penalties associated with penetrating the shield. The results of the study, as documented, concluded that the current engine design with the turbine lines routed around the external shield is more feasible. Design complexity, weight, engine performance, maintainability, reliability and the decisions contained in Change Order 70-8 (i.e., criteria requiring remote shield removal and replacement and elimination of the boost pumps) also contributed to substantiate the conclusion reached. (auth)

**21648** (TID/SNA-4) PROPELLANT FEED SYSTEM. Progress Review. (Aerojet-General Corp., Sacramento, Calif. (USA)). 27 Jan 1965. 144p. Dep. NTIS $10.25.

Material presented at a progress review meeting on NERVA turbopump design, development, materials, testing, etc. is listed. (LTN)

**21649** (TID/SNA-6) AUTOMATIC DATA PROCESSING LONG-RANGE PLAN REPORT. Buden, D.; Wells, R. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Jul 1970. 259p. Dep. NTIS $16.00.

Long-range planning of the automatic data processing activity was initiated by the Space Nuclear Propulsion Office, Washington, D. C., in September 1969, to evaluate the computer requirements of the NERVA Program for the time period between 1971 and 1975. The evaluation was to select the number of computer sites to best meet the NERVA Program requirements and to develop computer acquisition plans for the selected sites, making provisions for uncertainties in the requirements. The investigation resulted in the following recommendations: Use of decentralized computer facilities should continue. A central facility for the entire NERVA Program does not appear to be practicable, and the decision relative to using the NTO as a satellite facility to Sacramento should be made at such time as to support facility activation for testing in ETS-1. (auth)

**21650** (TID/SNA-9) ENGINE/COMPONENT DESIGN STATUS REVIEW. Phase I. Four Ongoing Components Presentations to SNSO, Sacramento, April 6, 7, 8, 1971. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 1971. 422p. Dep. NTIS $24.25.

Materials presented at a NERVA design status review of nozzle extension, Turbopump, valves and actuators, etc. is listed. (LTN)

**21651** (TID/SNA-11) THRUST VECTOR CONTROL GROUND TEST LIMITS TRADE STUDY. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Dec 1970. 128p. Dep. NTIS $9.50.

A trade study considers the problems involved in testing the operations of the thrust vector control (TVC) of an engine under test. The Nuclear Exhaust System of ETS-1 (which provides safe disposal of hydrogen, exclusion of air and limited altitude simulation) is not of sufficient diameter to allow a complete full range test of the TVC on an engine under test and there are uncertainties as to whether the exhaust duct might be damaged if the thrust direction is changed over the full range of control. It was considered unacceptable not to test the equipment for verification of performance and reliability and, on the other hand, modifications to provide a test over the full range of control would be very expensive in terms of time and money. Limited exhaust duct modifications (probably on E/STS-2) and restricted range of test (±1.0 degree and with controls on the rate of change) were recommended. (LTN)

**21652** (TID/SNA-191) NERVA FLIGHT SAFETY CONTINGENCY PLAN. (Aerojet-General Corp., Sacramento, Calif. (USA)). Dec 1968. 51p. Dep. NTIS $5.75.

The NERVA engine is being designed to accommodate a wide variety of missions involving both unmanned and manned space flight. These missions require nuclear engine operations along trajectories where sustained nuclear propulsion is mandatory for finite time periods to preclude early return and earth impact of the engine, accompanied by excessive radiation exposure to the earth's population. Also these missions place men into regimes of space where successful return of the crew requires NERVA operations at close to maximum efficiency for extended time periods. To assure minimum safety hazards to the crew and earth's population, maximum effort is being placed on an engine design which eliminates single failures, or credible combinations of failures, that can jeopardize successful completion of the reference missions. It is recognized, however, that regardless of the inherent safety and reliability incorporated into the engine system design, there will always exist some small but finite probability of failure which leads to or necessitates mission abort. Consequently, contingency plans have been developed based on an examination of the reference mission profiles and on potential system failures (classified as to their effect on the system). Their purpose is to define the possible contingency actions and recovery modes which can be taken for each failure class to maximize the chance for safe return of the crew and to minimize the possibility of early reentry and subsequent impact of the nuclear stage on a populated land mass. (auth)

**21653** (TID/SNA-206) PREDICTED SPECIFIC IMPULSE OF ADVANCED NUCLEAR ROCKET ENGINES. (Aerojet-General Corp., Sacramento, Calif. (USA)). 25 May 1961. 1p. Dep. NTIS $4.00.

Declassified 21 Aug 1968.

A graph shows curves of the predicted specific impulses as a function of nozzle area ratio of advanced nuclear rocket engines

for 3 bleed cycles and one topping cycle designs. The topping cycle is about 2 percent better. (LTN)

**21654** (TID/SNA-241) PERFORMANCE/DESIGN AND QUALIFICATION REQUIREMENTS FOR NOZZLE ASSEMBLY SUBSYSTEM. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Dec 1969. 18p. Dep. NTIS $4.00.

The nozzle assembly shall be capable of performing the following functions at the conditions and in the environments as specified herein: collect the hot exit gas from the reactor, accelerate it through the throat, and expand it in an efficient manner to produce a thrust of 75,000 ± 2,000 pounds at a nominal specific impulse of 822.8 lbf-sec/lbm and a minimum allowable specific impulse of 816 lbf-sec/lbm; transmit the generated thrust forces to the pressure vessel; receive the propellant from the pump discharge line and transmit the propellant within the temperature rise and pressure drop limits specified herein to the interface between the nozzle and the reflector; support the preload, acceleration, and pressure differential loads imparted by the nuclear subsystem and transmit them to the pressure vessel; and serve as an aft closure to the pressure vessel and nuclear subsystem providing the specified back pressure. These specifications are contained in a preliminary proposal issue for review only. (auth)

**21655** (TID/SNA-242) PERFORMANCE/DESIGN AND QUALIFICATION REQUIREMENTS FOR BY-PASS CONTROL VALVE AND ACTUATOR. (Aerojet-General Corp., Sacramento, Calif. (USA)). 15 Dec 1969. 19p. Dep. NTIS $4.00.

This specification establishes the performance, design, test and qualification requirements for equipment identified as By-Pass Control Valve and Actuator, hereinafter referred to as BCV Assembly, consisting of a valve and an electro-mechanical actuator system. The BCV assembly is to regulate the flow of propellant delivered to the turbine in response to control system demands during engine operation. (auth)

**21656** (TID/SNA-266) E-1 COMMON ANALOG MODEL. Revision 6.1 (RN-S-0469). (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 29 Dec 1970. 15p. Dep. NTIS $4.00.

Revised equations and information for the E-1 common analog model are presented. (LTN)

**21657** (TID/SNA-270) FINAL REPORT, CY 1970. Shielding Code Improvements, Project 393. Lindstrom, D. G. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Feb 1971. 71p. Dep. NTIS $6.75.

The development of improved shielding and radiation analysis computer codes is described. Work was carried out in three general areas: Code Coupling Improvements, Biasing in Monte Carlo Calculations, and Monte Carlo Code Improvements. Each was an extension of CY-1969 efforts to provide ANSC and NERVA with an efficient system of computer codes for analysis of difficult radiation transport and shielding problems. Efforts in CY-1969 were directed primarily toward producing the basic methods for solving these problems. Work in CY-1970 was directed mainly toward giving these methods the flexibility and efficiency for precise and economical analysis of the problems. Comparisons have shown that the techniques give results comparable with those by other methods and, in most cases, at a fraction of the cost. (auth)

**21658** (TID/SNA-273) SUPPLEMENT F004-CP090290-F1 FACILITY REQUIREMENTS DOCUMENT. Preliminary NRDS Test Cell "A" NERVA Turbopump 65MM Bearing Testing Facility Requirements. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Feb 1971. 26p. Dep. NTIS $4.50.

The Test Cell "A" facility and Special Test Equipment requirements necessary to support the "Evaluation Testing of LH Cooled 65 mm Rolling Element Bearings for the NERVA Engine TPA", are presented and are based upon applicable test requirements delineated in six reference documents. The information presented is to be used in the conceptual design and definitions of facility modifications and additions to support the referenced test program, the ROM cost of these modifications, and scheduling of detailed design/construction/activation and testing. Sufficient information is provided to develop modification criteria adequate for capability of testing 65 mm bearings at a maximum rate of 15 buildups per month, 15 hours testing per buildup. (auth)

**21659** (TID/SNA-277) TEST CELL "C" NERVA PUMP COMPONENT DEVELOPMENT FACILITY REQUIREMENTS. Popham, D. A. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). Nov 1970. 30p. Dep. NTIS $4.50.

The Cryogenic Evaluation Laboratory (CEL) complex at Test Cell "C" is being modified for NERVA $LH_2$ turbopump component testing. The flexibility and capabilities of the CEL will be expanded by the modifications so that future testing will be enhanced. The facility will provide the $LH_2$ test loop flow characteristics required to conduct integrated tests and demonstrate operational readiness of the NERVA turbopump inducer, first and second stage. Initial modification will provide the capability for conducting $LH_2$ first stage testing for approximately 8 minutes at 100 lb/sec, with suction from both 55,000 gal $LH_2$ dewars. (auth)

**21660** (TID/SNA-279) DETAIL SPECIFICATION, PART 1: PERFORMANCE/DESIGN AND QUALIFICATION REQUIREMENTS FOR ENGINE, NERVA, 75K, FULL FLOW. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). [nd]. 133p. Dep. NTIS $9.75.

This part of this specification defines the requirements for the performance, design, and qualification of equipment identified as the NERVA Nuclear Rocket Engine, Contract End Item (CEI) No. 90290 as established by the NERVA Program Requirements Document, SNPO-NPRD-1. This CEI, hereinafter referred to as the engine, is used as a source of primary propulsive power for both manned and unmanned space vehicle applications. The engine is designed to operate at a vacuum thrust level of 75,000 lbs and a specific impulse of 825 seconds and shall be man rated. The engine requires externally supplied liquid hydrogen, command signals, and electrical power. Rated thrust is achieved at a nominal thrust chamber pressure of 450 psia and a nominal design thrust chamber temperature of 4250° Rankine and with a nozzle having an expansion ratio of 100 :1. Endurance at rated temperature shall be 600 accumulated minutes. The operating time is utilizable in multiple cycles up to 60 with durations of varying lengths up to 60 minutes. Numerous other requirements and specifications are given. (auth)

**21661** (TID/SNA-291) SNPO-C NOZZLE DESIGN REVIEW. (Aerojet-General Corp., Azusa, Calif. (USA)). 22 Jan 1964. 55p. Dep. NTIS $5.75.

Material presented at a design review meeting on NERVA nozzles has been recorded. (LTN)

**21662** (TID/SNA-292) RELIABILITY AND QUALITY ASSURANCE INFORMAL PROGRESS LETTER NO. 44A FOR FIRST QUARTER, CY 1968 COVERING OCTOBER, NOVEMBER, AND DECEMBER 1967. (Aerojet-General Corp., Sacramento, Calif. (USA)). Jan 1968. 25p. Dep. NTIS $4.25.

Efforts in the areas of reliability and quality assurance are described, with several specific operations or items being treated in some detail. Data books, end-item reports, failure-mode analysis, design-review reports, and technical reliability reports are being filmed on microfiche and retained as historical files. (LTN)

**21663** (TID/SNA-294) RELIABILITY AND QUALITY ASSURANCE INFORMAL PROGRESS LETTER NO. 45A FOR SECOND QUARTER, CY 1968 COVERING JANUARY, FEBRUARY, AND MARCH 1968. (Aerojet-General Corp., Sacramento, Calif. (USA)). Apr 1968. 27p. Dep. NTIS $4.50.

Efforts in quality assurance, failure mode analysis, and reliability are reviewed, both generally and specifically for certain items. (LTN)

**21664** (TSCS-ATP-003) TSCS ACCEPTANCE TEST PROCEDURE FOR NERVA ENGINE. ETS-1 NUCLEAR INSTRUMENTATION SUBSYSTEM. Issue 7. (Aerojet-General Corp., Sacramento, Calif. (USA)). 6 Mar 1967. 54p. Dep. NTIS $10.75.

Instructions, test procedures and verification criteria are established for the acceptance testing of the ETS-1 Nuclear Instrumentation Subsystem. Verification is to be accomplished by the insertion of calibrated signals to verify interface function. (LTN)

**21665** (WANL-67-4) MODEL EXPERIMENTS FOR E/STS 2, 3 WET DUCT EXHAUST SCRUBBER. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Mar 1967. 76p. Dep. NTIS $7.00.

A major potential problem in the ground testing of nuclear rocket engines is the release of fission product activity to the environment. This problem may become even more acute when nuclear rockets of enormous size are tested in the new Engine System Test Stands (E/STS 2,3). It is therefore necessary to consider the technical concepts required for removing radioactive material of future reactor exhaust gas in order to protect the operating personnel and the public. A recent development is a method to cool the torrid rocket gas exhaust to temperature levels where a more simple and rugged duct and collection system could be used and maintained. This involves the introduction of sufficient quantities of water into the extremely hot hydrogen stream exhausting from a nuclear rocket engine to reduce the bulk temperature to levels where cooling of the duct walls and other component parts is not required. The area of greatest concern that now remains is the investigation and design of an effective radioactive gas scrubber and particulate collector. From a biological hazard standpoint, radioactive iodine and its precursors (tin, antimony,

and tellurium) are the undesirable contaminants that have deposited downwind from the reactor effluent cloud, and must now be collected. To collect this particulate, a preliminary evaluation has recommended the use of a gas scrubber system. A program to supplement the scrubber design effort through scale model experiments is required. (auth)

**21666** (WANL-PR(J)-038(Suppl.1)) MILESTONE SUMMARY. Progress Report, April 1, 1965—June 30, 1965. NERVA Nuclear Subsystem. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 23 Jul 1965. 77p. Dep. NTIS $7.00.

A management survey is given of progress in which task and project areas are listed with scheduled completion dates, actual completion dates, changes, etc. (LTN)

**21667** (WANL-TME-186) LOADS IMPOSED ON AGC PRESSURE VESSEL BY NRX-A REACTOR. Selz, A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 2 Nov 1962. 3p. Dep. NTIS $4.00.

The maximum loads imposed on the nozzle by the reactor have been calculated to be 34,000 lb axial and 58.7 lb/in. radial. (auth)

**21668** (WANL-TME-210) NRX-A PRESSURE VESSEL AND NOZZLE. Bragg, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 Nov 1962. 2p. Dep. NTIS $4.00.

Information is given about pressure vessels, nozzles, etc. and their handling fixtures, shipping and storage containers, etc. in order to prepare facilities for testing. (LTN)

**21669** (WANL-TME-236) PERSONNEL TRAINING PROGRAM FOR NRX TEST OPERATION. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Dec 1962. 8p. Dep. NTIS $4.00.

**21670** (WANL-TME-248) NRX TEST CARS. Division of Responsibility. Poindexter, A. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 11 Jan 1963. 2p. Dep. NTIS $4.00.

**21671** (WANL-TME-252) NERVA NEUTRON DETECTOR DEVELOPMENT PLAN. Candidate Transducer Data Sheets. Austin, W. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 19 Jan 1963. 9p. Dep. NTIS $4.00.

Development plans for neutron detectors are outlined with the specifications required for operation at various neutron fluxes. (LTN)

**21672** (WANL-TME-267(Rev.)) PROPOSED REVISION TO THE WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY. Reactor Operations Manual. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1966. 154p. Dep. NTIS $10.75.

A proposed revision of the WANEF manual of administrative controls, personnel responsibilities and reactor operating procedures is presented for review. (LTN)

**21673** (WANL-TME-267(Rev.B)) WANEF OPERATIONS MANUAL. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Oct 1965. 138p. Dep. NTIS $10.00.

This manual contains the WANEF administrative controls, personnel responsibilities, and operating procedures. Also included are brief descriptions of the facility and its control and safety systems. Operations will be conducted within the boundaries of this document, of WANL-TME-1295, "WANEF Operating Limits", and within the framework of WANL-TNR-099, "Safety Report for the Westinghouse Astronuclear Experimental Facility" and its supplements. (auth)

**21674** (WANL-TME-267(Rev.D)) WANEF OPERATIONS MANUAL. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1966. 36p. Dep. NTIS $5.00.

This manual contains the WANEF administrative controls, personnel responsibilities, and operating procedures. Also included in the manual are a brief description of the facility and its control and safety systems. (auth)

**21675** (WANL-TME-267(Rev.E)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY REACTOR OPERATIONS MANUAL. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1967. 154p. Dep. NTIS $10.75.

The manual contains administrative controls, personnel responsibilities and reactor operating procedures. The facility and the control and safety systems for the reactors are described briefly. Operations will be conducted within the boundaries of this report and of other applicable referenced reports involving operating limits and safety. (LTN)

**21676** (WANL-TME-298) PRELIMINARY INVESTIGATION OF THE DYNAMIC CHARACTERISTICS OF THE NRX-A1 LATERAL SUPPORT SYSTEM. Stancampiano, P. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Mar 1963. 13p. Dep. NTIS $4.00.

The results of a preliminary investigation into the dynamic characteristics of the NRX-A1 lateral support system are discussed. The lateral natural frequencies of the core and two modes of the support leaf springs were calculated to be 10, 155, and 1950 cps respectively. Core resonance will not occur simultaneously with spring resonance. However, there is a possibility of core resonance at 10 cps. The present damping in the spring system consists essentially of erratic coulomb friction. Several methods for increasing the system's positive damping were investigated. The use of graphite cloth appears to provide the most damping without increasing the spring stresses. The optimization of the core bundling force distribution was studied. A uniform force distribution, as in the present design, appears to be best at this stage of development. Additional study into increasing the damping should be continued. More information concerning lateral modes shapes and dynamic core displacements is required to fully optimize the lateral support design. (auth)

**21677** (WANL-TME-300) STABILITY OF CORE LATERAL SUPPORT. Scialdone, J. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 15 Mar 1963. 27p. Dep. NTIS $4.50.

The core structure of the NERVA Reactor consists of fuel element clusters suspended from the support plate and bundled together by a lateral spring support system extending the length of the core. The lateral support arrangement provides a means to absorb lateral static, vibrational, and shock loads during handling, shipping, booster, and nuclear operation. Various transient and steady state flow disturbances, such as chugging, wave motion of cylindrical and longitudinal modes, cavity resonances, eddies, and others may occur under certain propellant flow conditions. These disturbances may originate oscillations of the core or parts of the core. Insufficient positive damping, coupled with a source of energy provided by the combined interaction of the geometry, the pressures and the flow existing in the system, may not suppress the initial oscillation, but sustain and increase them to the extent of causing failure of parts. The analysis considers three cases of leakage at the flow inlet and exit of the core and derives the required conditions for static and dynamic stability of the core. Values of lateral support spring constants required to statically stabilize the core are presented parametrically. The results indicate that, for the assumptions of this analysis, the NRX-A design has sufficient lateral support spring force to insure that the core is statically stable within a considerable range of pressure drops and leakage areas in the core. (auth)

**21678** (WANL-TME-324) REACTOR CONTROL PANEL, ETS-1 CTO CONSOLE, DRAWING 707J888. Kendziorek, W. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Apr 1963. 7p. Dep. NTIS $4.00.

**21679** (WANL-TME-340) REQUEST FOR TEST CELL A MODIFICATIONS. Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 May 1963. 29p. Dep. NTIS $4.50.

Recommended modifications to extend Test Cell "A" Capabilities for NRX Testing have been reviewed and subdivided into funding categories: FY 1963, FY 1964, LASL performed, and modifications for which no additional funds are requested. The modifications are described (with justifications and estimated costs). (LTN)

**21680** (WANL-TME-348) DESIGN RESPONSIBILITY FOR THE NRX REMOTE NOZZLE HANDLING FIXTURE AND CLOSURE/NOZZLE BOLT REMOVAL TOOL. Bragg, R. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 13 May 1963. 2p. Dep. NTIS $4.00.

Design and fabrication responsibilities are defined for a remote nozzle handling fixture and for a closure/nozzle bolt removal tool required for remotely removing the captured upset forward closure bolts. (LTN)

**21681** (WANL-TME-355(Suppl.2)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY (WANEF). Experimental Plan for NRX-A. Barksdale, C. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1964. 11p. Dep. NTIS $4.00.

An experiment design has been developed for performance of a sampling reactivity check for variations in NRX-A manufactured fuel elements. This experiment is to serve as an

auxiliary measurement capability when the performance of a Proof Test Experiment (PTX) or a Pre-Assembly Experiment (PAX) cannot be executed due to component delivery schedules. Other technical and programmatic considerations could lead to the performance of this test on any particular reactor, but the specific design has been prepared for application on NRX-A3. Fuels from different production sources will be tested in a critical assembly and the results analytically applied to the prediction of reactivities for specification of reactivity shimming for a complete reactor. It has been called the Permanent Pre-Assembly Experiment (PPAX) and is made up of the NRX-A1 outer reflector and reject components and fuel that will not be used in future hot test reactors. (auth)

**21682** (WANL-TME-372) NERVA NUCLEAR SUBSYSTEM. Government Furnished Equipment Requirements NRX-A1 Test Operations at NRDS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 May 1963. 122p. Dep. NTIS $9.25.

Support equipment to be fabricated, purchased or requested from existing inventories, needed for the NRX-A1 Test, is listed. (LTN)

**21683** (WANL-TME-373) NERVA NUCLEAR SUBSYSTEM. Government Furnished Equipment Requirements, NRX-A1 Test Operations at NRDS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jun 1963. 16p. Dep. NTIS $4.00.

A list of support equipment needed for NRX-A1 test operations is divided into items to be purchased and items available at LASL or NRDS. (LTN)

**21684** (WANL-TME-374) PERFORMANCE CRITERIA FOR AN NRX-A PROPELLANT FEED SYSTEM USING MIXING CHAMBER PRINCIPLE. Kutilek, J. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 29 May 1963. 5p. Dep. NTIS $4.00.

A set of criteria is provided for use in testing and evaluating the feed system. The criteria involve required performance goals and guides (which cannot yet be stated as firm requirements). (LTN)

**21685** (WANL-TME-387) POSSIBLE NOZZLES FOR USE WITH NRX-A. Retallick, F. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 Jun 1963. 6p. Dep. NTIS $4.00.

All three nozzles will provide the necessary gaseous and liquid flow rates to meet the test and operational requirements of the NRX-A reactors. There are, however, some uncertainties in the nozzle exit temperature and the reflector inlet temperature (and in the methods of calculating them) which should be resolved. Also, if the current nozzle design is replaced, interfacing and installation problems will need to be coordinated. (LTN)

**21686** (WANL-TME-389) ANALOG COMPUTER B-5 TESTS. Burack, R. D.; Maguire, A. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 11 Jul 1963. 13p. Dep. NTIS $4.00.

The response of a single degree of freedom system to excitation by a sinusoidal lateral displacement of its support structure was determined on the analog computer. The system was damped by coulomb friction and coupled by linear springs. An explanation of the response characteristics, some typical curves of displacements, velocities, etc., and the computer circuit diagram are given. The constants used in the analog program were approximately equal in magnitude to those of the B-5 partial core. (auth)

**21687** (WANL-TME-394(Rev.14)) NRX BLOCK I, OPERATIONAL SUPPORT PLAN. Volume II. NERVA Support Equipment Provisioning List and Schedule for NRX-A2. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 15 Sep 1964. 196p. Dep. NTIS $13.00.

Support equipment needed for the NRX-A2 reactor tests are listed with schedules for design, fabrication or purchase, inspection, etc. (LTN)

**21688** (WANL-TME-408) NRDS EQUIPMENT INVENTORIES, PLANT EQUIPMENT, KIWI SUPPORT EQUIPMENT. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 25 Jun 1963. 131p. Dep. NTIS $9.75.

NRDS inventories of equipment, plant equipment and KIWI support equipment are listed as of June 25, 1963. (LTN)

**21689** (WANL-TME-416(Rev.4)) NERVA SUPPORT EQUIPMENT PROVISIONING LIST AND SCHEDULE FOR NRX-A1. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Nov 1963. 82p. Dep. NTIS $7.25.

**21690** (WANL-TME-437) REACTOR ASSEMBLY AREA CRITICALITY HAZARDS CONTROL PROCEDURE, REVISION 1, SECTION 7. Addendum No. 5. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 3 Dec 1964. 3p. Dep. NTIS $4.00.

Changes in criticality zones of the facility are listed and fuel material limits and permissible arrangements specified. (LTN)

**21691** (WANL-TME-512) NRX-A STRESS CRITERIA. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1963. 10p. Dep. NTIS $4.00.

The object of this set of Stress Criteria is to establish a consistent and realistic set of ground rules to be followed in all reactor structural analyses. The majority of components analyzed will conform to the criteria set forth in this report; however, a few will not. These nonconforming parts must be considered on an individual basis. Various stresses, including thermal and vibratory stresses, are considered for both ductile and brittle materials. The terms used are defined. (LTN)

**21692** (WANL-TME-603) SELECTION OF MATERIAL, NUMBER AND DISTRIBUTION OF POISON WIRES FOR THE ANTICRITICALITY POISON SYSTEM. Call, D. W.; Parker, G. E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 19 Nov 1963. 20p. Dep. NTIS $4.00.

A slight anticriticality poison system (ACPS) is being developed as a special safety measure to prevent accidental criticality of the NERVA reactor. The system as presently envisioned consists of sufficient poison wires (or poison filled tubes) in the reactor core to prevent criticality during both the preflight period and in the flight period prior to startup. It will also be used during periods of credibly maximum danger produced by any conceivable accident or hazard situation. These wires would be inserted into the reactor core coolant channels from the nozzle end. A mechanism of novel design will be used to extract the wires at a predetermined point in flight and prior to second and third stage separation. The wires must be sufficiently clear of the reactor so that it can attain criticality before the stages separate. Tests have been conducted to determine the feasibility of this concept. They indicate that plastic-coated poison wires can be used and extracted from the core in about ten seconds without damage to either the wires or the reactor. Test data has also been obtained on the mechanical forces required to extract the wires. (auth)

**21693** (WANL-TME-757) PROPOSAL FOR MEASUREMENT OF NRX-A2 REACTOR AND FACILITY TRANSFER FUNCTIONS BY CROSS-CORRELATION WITH PSEUDO-RANDOM BINARY INPUT SIGNALS. Wasserman, A. A.; Honka, E. K.; Steiner, G. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Apr 1964. 33p. Dep. NTIS $4.75.

A proposal is made for the performance of system transfer function measurements during the NRX-A2 test series. The measurements will be made by applying small-amplitude, binary input signals of predetermined statistical properties, to a few selected control points in the system during periods of steady-state operation, and performing off-line, digital cross-correlation of selected system variables with synchronized records of the applied input signals. This technique, originally developed in connection with adaptive control of aircraft, has been used with success by LASL during the KIWI-A3 tests without interfering in any way with other simultaneous measurements of system performance. Additional such measurements are planned during the forthcoming LASL tests of the KIWI-B-4D reactor system. No special operation of the reactor system is required and the performance of these measurements as planned will in no way interfere with meeting the other objectives of the NRX-A2 Tests. (auth)

**21694** (WANL-TME-926) NRX-A1 INTERNAL INSTRUMENTATION. Final Post Operative Report. Chambers, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Aug 1964. 36p. Dep. NTIS $5.00.

The physical appearance of the NRX-A1 internal instrumentation at the time of disassembly looked good. A considerable amount of contamination was found during disassembly (consisting mostly of gold chips, epoxy, potting compound and pieces of transitioning material) which most likely fell into the core during assembly. The shrinkable tubing used to cover assembly transitions and connectors experienced a few splits but did not chip or break away nor cause direct failure to any of the instrumentation. The epoxy used to hold instrumentation leads to a metal surface in many cases became cracked and unbonded. Some lead retainers and mounting devices were not secured, even with the locking devices intact. It appears that much damage occurred to the instrumentation during disassembly, for thermocouples were found with broken or open junctions, yet had been operative during testing. A total of 34 instrumentation circuits had designation numbers which differed from those NRDS thought them to be. In the majority of these cases, the

instrumentation leads did not route through the proper hole in the braze plug. The number of internal instrumentation circuits found electrically defective during disassembly was 53. Of these, only 22 were concluded as being defective or failing during EP tests. Damage at NRDS and WANL disassembly accounted for the remaining. The point of defect for the majority of these was at the transition made by the vendor, where the metal sheath conductors are spliced to flexible lead. Other areas causing trouble were incorrect wiring, the exposed junctions of thermocouples breaking open, defect at strain gage and terminal, and damage to conductors during assembly, etc. After disassembly, over half of the strain gages were still bonded and it was concluded that only 16 were unbonded or became unbonded during EP testing. The gages on the elements remained bonded much longer than those on the inner reflector graphite, stainless steel and titanium. The overall transducer functional performance was good. Of the transducers in which performance was questionable, recalibration showed that only three should be considered unreliable. In summation, the major internal instrumentation problems were not with the transducers but with the connection circuits and bonding material associated with the transducers. From a total of 342 internal circuits, only 38 were concluded as being inoperative or failing during reactor tests. Several recommendations for future work are made. (auth)

**21695** (WANL-TME-930(Rev.1)) NERVA SUPPORT EQUIPMENT PROVISIONING LIST AND SCHEDULE FOR NRX-A4. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 15 Sep 1964. 8p. Dep. NTIS $4.00.

Additional support equipment needed for the NRX-A4 test is listed, with schedules for purchase, fabrication, etc. (LTN)

**21696** (WANL-TME-935) CONTROL ACTUATOR COMPONENT IRRADIATION TEST 14/W003. Hornberger, D. W. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 28 Aug 1964. 64p. Dep. NTIS $6.25.

The torquemotor, potentiometer, and piston-seals used in the first Generation Control Actuator were tested operationally to $10^{18}$ nvt at approximately 560°R. Operating performance results indicated the following: Potentiometer — no change in the mechanical or electrical properties as measured by the voltage smoothness and noise characteristics; torquemotor — no change in the dynamic properties due to radiation; piston-seal — retained its strength properties, but evidenced a large increase (260 per cent) in friction values as the nvt built up. In addition, the first attempt at a heat transfer evaluation of these components has indicated the following: potentiometer — the potentiometer case is an extremely good conduction path for the heat generated internally and in the potentiometer housing cover; torquemotor — the internal temperature (disregarding a minute hot-spot) should not exceed the incoming gas temperature by more than 50-60 degrees; piston-seal-cylinder — indications are that the coolant passages around the cylinder sleeve are not as effective as expected, but are sufficient to prevent an excessive temperature build-up. (auth)

**21697** (WANL-TME-940) NRX-A2 FACILITIES FAILURE MODE ANALYSIS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 20 Sep 1964. 227p. Dep. NTIS $14.50.

In order to provide assurance that the NRX-A2 reactor, facility, and control systems are suitable for a hot test, failure mode analysis has been applied to 9 major subsystems and, in less detail, to 8 other less critical systems. Certain recommendations have been made which should improve reliability. (LTN)

**21698** (WANL-TME-1035) ALUMINUM BAR-X SEAL TESTS. Test Series FFL-13. Edmiston, J. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Nov 1964. 22p. Dep. NTIS $4.25.

In the NRX-A reactor pressure vessel instrumentation ports an inconel Bar-X seal is employed. If the seal plug is damaged to the extent that the seal is not effective, remachining the plug is not possible. A silver plated aluminum Bar-X seal's effectiveness in extending the range of ability to seal such a damaged plug was tested. The test required pressurizing with hydrogen gas one side of the seal, under ambient and cryogenic temperatures, and measuring seal leakage. A seal plug, with a common interface with the internal diameter of the Bar-X seal, was scored perpendicular to the seal with a Vee groove, first, .002-inch deep and wide and, then, 0.0052-inch deep and .0082-inch wide. With 260 ft-lbs of torque on the seal nut, the 0.002-inch deep Vee groove sealed within allowable limits but the .0052-inch deep Vee groove failed to seal effectively. The silver-plated aluminum Bar-X seal is an effective seal for this application on a 0.002-inch wide and deep axial score. Where the plug is damaged, this seal will be effective at a lower torque than the inconel Bar-X seal. A white powder coating was found on the seal after test. The silver plating had caused electrolysis at the sealing surfaces, which may prohibit the use of this type of seal coating in the reactor. (auth)

**21699** (WANL-TME-1036) CONOSEAL BAR-X SEAL TESTS. Edmiston, J. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Nov 1964. 23p. Dep. NTIS $4.25.

On the NRX-A reactors the instrument ports are sealed by a Bar-X seal. Damage to the ports, which are part of the pressure vessel, required machining on the pressure vessel. A new design, using a Marman flanged piece to house the Bar-X seal port separate from the pressure vessel, was proposed. The test program was to determine the torque required to seal and the ability of each seal to hold during thermal shock. The Bar-X seal did not leak as in previous test programs, but after cold shock the Marman flange Conoseal gasket sealed marginally at ambient temperature. (auth)

**21700** (WANL-TME-1039) SMALL SCALE SEAL TEST HHT-11 (DESIGN REPORT). Ferris, J. R.; Steffen, R. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA) Astronuclear Lab.). Nov 1964. 78p. Dep. NTIS $7.00.

A small, circular rig which heats hydrogen flowing through a series of steps in an annulus defined by two graphite barrels has been designed, built, and run. The initial test data from this rig have proved useful in serving as a basis of comparison with results from analytical studies which employ the same techniques and methods used in the study of heat transfer and hydrogen flow in the reactor lateral support system. Shortcomings of the rig are reviewed. The rig needs improvements and development in two broad categories. One involves investigation and refinement of temperature distributions in the graphite barrel structures including elimination of hot and cold areas and including a description of axial temperature distributions in the heater element together with end thermal losses. The other involves raising the temperatures of the graphite barrels and of the hydrogen to levels at which hydrogen corrosion can be studied. It is recommended that development of the rig be pursued along the lines indicated in this report in order to obtain the experimental information required in substantiating the detailed information of the analytic program. (auth)

**21701** (WANL-TME-1047) WANL CALIBRATIONS FOR NRX-A3. Burlas, T. C.; Karako, E. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 11 Dec 1964. 118p. Dep. NTIS $9.00.

**21702** (WANL-TME-1049) PRELIMINARY ANALOG-COMPUTER STUDY OF THE CROSS-CORRELATION IMPULSE-RESPONSE MEASUREMENT TECHNIQUES TO DETERMINE OPTIMUM INPUT-SIGNAL CHARACTERISTICS. Honka, E. K.; Steiner, G. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 21 May 1964. 38p. Dep. NTIS $5.00.

The use of cross-correlation methods with a pseudo-random input signal of small, fixed amplitude and pulse-like character can be used to determine the impulse response of a linear system in a brief time even in the presence of substantial system noise. A preliminary effort at gaining familiarity with the cross-correlation technique of impulse-response measurement in preparation for use of the technique to make system transfer function measurements during the NRX-A2 test series is reported. Of particular interest was the study of the relation between the parameters of the pseudo-random signal produced by a feedback shift register and the accuracy of the resulting impulse-response computation for a specified system. Also of interest in the study was the effectiveness of the cross-correlation technique to eliminate or greatly reduce the effects of system noise on the calculated impulse response. It was concluded that the pseudo-random input signal should have a sequence length of at least twice the test system settling time, that the basic pulse interval $\Delta T$ of the pseudo-random signal should be no greater than about $^1/_{10}$ of the period of the highest natural frequency component of the test system, and that system noise is most likely to cause inaccuracy in the impulse response results when the noise is within the frequency pass band of the test system. (auth)

**21703** (WANL-TME-1055) MEASUREMENT REQUIREMENTS LIST NRX/EST. Zellner, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1964. 8p. Dep. NTIS $4.00.

The transducers (and their parts numbers) are listed for each measurement (with the measurement number) required in the NRX-4A-EST Test. (LTN)

**21704** (WANL-TME-1057) PRELIMINARY EVALUATION OF PRESSURE DROP AND TEMPERATURE RISE IN EST PUMP SUCTION. Farquhar, N. G. (Westinghouse Electric Corp., Pitts-

burgh, Pa. (USA). Astronuclear Lab.). 14 Dec 1964. 9p. Dep. NTIS $4.00.

The EST pump will be located on the test car at a considerable distance from the liquid hydrogen dewar. Therefore, pressure drop in the pump suction line will be greater than it was for the NRX tests. In addition, certain items of equipment which are located in the pump discharge piping for NRX tests will be relocated to the suction piping for the EST, thereby increasing the pressure loss between dewars and pump. The predicted pressure drop and temperature rise for the EST pump suction piping system are presented. (auth)

**21705** (WANL-TME-1063) PRIVY ROOF MOUNTED SHIELD PROPOSAL. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 17 Dec 1964. 44p. Dep. NTIS $5.25.

The proposed shield represents a straight forward design which gives maximum flexibility in test car plumbing design. It also prevents the problems relative to hydrogen gas accumulation since this is impossible, and fires previously experienced will not effect the water-cooled aluminum shield. In addition, design problems relative to component shielding will be eliminated. The extension of the privy roof shadow shield in the close proximity of the reactor will reduce by approximately 90 per cent the radiation emitted by the reactor in the 135° sector that is shielded. This will appreciably reduce the test cell wall activation as well as other parts of the facility. The proposed shield on the NRX-A3, considering only 20 minutes of full power run time, would reduce facility activation considerably. Without this shadow shield activation of the test cell facility could become a major problem with long full power tests and certain critical components (activator seals, hydraulic fluid, electronic cables) could be damaged by the radiation levels. (auth)

**21706** (WANL-TME-1081) NRX-A2 DOSIMETRY MEASUREMENTS. Brooks, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1965. 39p. Dep. NTIS $5.00.

The major conclusions that can be drawn as a result of the NRX-A2 dosimetry measurements are: The results adequately define the thermal and epithermal neutron flux distribution about the reactor at the points investigated. Due to insufficient correlation between the results of the low and high power runs, the gamma and neutron leakage radiation per watt for a cold and operating reactor has not been established. With few exceptions there is close agreement for gamma exposure rates and fast neutron fluxes within known uncertainties. Thermal flux distributions obtained from gold, cobalt and copper agree with calculated distributions. Gamma exposure rate and fast neutron flux measurements on the pressure vessel should be repeated on the NRX-A3 test to increase the accuracy and precision of the data. This can be accomplished with a high power run and thermoluminescent dosimetry. (auth)

**21707** (WANL-TME-1092) NRX/EST PROPELLANT FEED SYSTEM, DESIGN PACKAGE—1. Moss, B. F.; Johnson, F. T. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 28 Jan 1965. 63p. Dep. NTIS $6.25.

The conduct of an engine system test in Test Cell "A" requires the addition of a propellant feed system to supply liquid hydrogen to the engine turbopump. These requirements are fulfilled by the addition of an eight inch vacuum jacketed line to provide liquid hydrogen to the engine turbopump, the rerouting of the existing propellant feed line, and the provision of removable spool pieces at the facility pump to allow rapid configuration changes. Prior to the first nuclear test of the NRX/EST, a facility checkout test of the "reactor only" piping configuration will be performed through the bypass line on the test article to verify that no significant changes to system characteristics were introduced by this modification. (auth)

**21708** (WANL-TME-1095) FINAL TEST SPECIFICATIONS FOR A STRUCTURAL MATERIALS TEST TO BE CONDUCTED AT THE PLUM BROOK REACTOR (37/W402). Blinn, H. O.; Begley, J. A.; Zorn, J. B.; Rothleder, B. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1965. 16p. Dep. NTIS $4.00.

Specifications are listed for a radiation effects test of tensile specimens of NERVA tie rod material. (LTN)

**21709** (WANL-TME-1095(Rev. 1)) FINAL TEST SPECIFICATIONS FOR A STRUCTURAL MATERIALS TEST TO BE CONDUCTED AT THE PLUM BROOK REACTOR (37/W402). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1966. 4p. Dep. NTIS $4.00.

The final specifications of the post-irradiation tests on a structural material have been revised by replacing a strain rate study with an embrittling evaluation. (LTN)

**21710** (WANL-TME-1169(Add.1)) ADDENDUM TO NRX-A3 EP-VI CONTROL TEST ANALYSIS AND SIMULATION. Cooper, K.; Junker, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 26 May 1965. 40p. Dep. NTIS $5.00.

The results of additional step and sinusoidal perturbation runs in the analog computer analysis and simulation of EP-VI NRX-A3 control tests are reported. (LTN)

**21711** (WANL-TME-1230) NRX/EST OPERATING LIMITS. Interim Limits for Pre-Criticality Operations. Skaritka, J.; Vachon, L. J.; Hemmerle, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 26 Jul 1965. 12p. Dep. NTIS $4.00.

The constraints, within which NRX/EST reactor operations will be accomplished prior to initial criticality, are defined. The operations include receiving, inspection, assembly, poison wire removal, transport to test cell "A" and checkout. (LTN)

**21712** (WANL-TME-1264) NRX/EST TRANSDUCER STATUS REPORT. Figenbaum, E. K. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 24 Aug 1965. 45p. Dep. NTIS $5.25.

The instrumentation channel number, part number, serial number and status of transducers required for the NRX/EST tests are reported. The number, problem and comments of all abnormalities recorded on VR, NMDR or FDDR's against each transducer are included. (auth)

**21713** (WANL-TME-1293) TWO RAYTHEON 250 COMPUTER SUBROUTINES. Rankin, W. D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1965. 29p. Dep. NTIS $4.50.

Two subroutines for the Raytheon 250 computer were developed. The first involves a combination and modification of two Raytheon-supplied subroutines, the Decimal Input-Output 1A, and the Floating Point Package. The purpose of the modification is to simplify the writing of programs using these subroutines by providing input and output between fixed point numbers on the typewriter keyboard and floating point numbers in the computer memory. Since keywords are required for these functions, the ease of use is improved. The second subroutine is designed to replace an existing Raytheon-supplied subroutine which provides control of a Calcomp digital incremental recorder. The purpose of re-writing this subroutine was to provide increased versatility. Whereas the original program could plot only one symbol, the new program can plot any one of seven. Also, the new program can plot a line which more closely approximates a straight line between two given points. (auth)

**21714** (WANL-TME-1295(Rev.)) PROPOSED REVISION TO THE WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY OPERATING LIMITS. Frantz, F. S., Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1966. 27p. Dep. NTIS $4.50.

**21715** (WANL-TME-1295(Rev.B)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY OPERATING LIMITS. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1966. 14p. Dep. NTIS $4.00.

In accordance with AECM 8401-044, limits are defined within which the Permanent Assembly Experiment (PAX) and Flexible Critical Experiment (FCX) may be operated with reasonable assurance that undue hazard will not result. Included are design specifications, operating variables, operating procedures and administrative procedures, which can influence safe operation and are under control. This revision supersedes prior documents of type and with WANL-TME-267, Rev. D (operations manual) and WANL-TNR-099 (Safety Report) defines operating requirements. (LTN)

**21716** (WANL-TME-1295(Rev.C)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY OPERATING LIMITS. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1967. 27p. Dep. NTIS $4.50.

In accordance with AECM 8401-044, limits are defined within which the Permanent Assembly Experiment (PAX) and Flexible Critical Experiment (FCX) may be operated with reasonable assurance that undue hazard will not result. Included are design specifications, operating variables, operating procedures and administrative procedures, which can influence safe operation and are under control. This revision supersedes prior documents of this type and with WANL-TME-267, Rev. E (operations manual) and WANL-TNR-099, Rev. A (Safety Report) defines operating requirements. (LTN)

**21717** (WANL-TME-1295(Rev.D)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY OPERATING LIMITS. Williams, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1968. 27p. Dep. NTIS $4.50.

In accordance with AECM 8401-044, limits are defined within which the Permanent Assembly Experiment (PAX) and Flexible Critical Experiment (FCX) may be operated with reasonable assurance that undue hazard will not result. Included are design specifications, operating variables, operating procedures and administrative procedures, which can influence safe operation and are under control. This revision supersedes prior documents of this type and with WANL-TME-267 (latest approved issue of Operations Manual) and WANL-TNR-099 (latest approved issue of Safety Report) defines operating requirements. (LTN)

**21718** (WANL-TME-1295(Rev.E)) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY OPERATING LIMITS. Frantz, F. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1969. 9p. Dep. NTIS $4.00.

The WANEF nuclear facilities (PAX and FCX) are described. Means of preventing inadvertent criticality are listed and the operating limits on reactor experiment parameters are given. Fuel storage limitations and reactor shutdown systems are described. (LTN)

**21719** (WANL-TME-1347) ANALYSIS OF PERFORMANCE OF PCV-41 FLOW SHUTDOWN SYSTEM FOR NRX/EST ENGINE SYSTEM TESTING. Wright, J. B.; Rovnak, J. A.; Wasserman, A. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Dec 1965. 29p. Dep. NTIS $4.50.

The performance of the PCV-41 flow shutdown system in NRX/EST engine system testing has been analyzed. Major emphasis is given to the effectiveness of the PCV-41 gas flow system in fulfilling the reactor, nozzle, and facility requirements which must be met in order to assure that the system can be safely restarted following a flow shutdown. Included are a summary of the reactor, nozzle, and facility constraints; a brief description of the analog model and the methods used to validate the model, including comparisons with test data; predictions of shutdown performance from various transient and steady-state points on the NRX/EST operating map; and comparison of predicted results with the reactor, nozzle, and facility constraints. (auth)

**21720** (WANL-TME-1378) BETALS: A FORTRAN II PROGRAM FOR CALCULATING BETA-EFFECTIVE ($\beta_{eff}$) AND PROMPT NEUTRON LIFETIME ($l_p$) FOR A REACTOR WITH GIVEN FLUX ($\phi$) AND ADJOINT ($\phi^+$) SOLUTIONS. Gray, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1966. 63p. Dep. NTIS $6.25.

A computer program is provided for calculating beta-effective ($\beta_{eff}$) and prompt neutron lifetime ($l_p$) for a reactor with (two dimensional) multigroup flux ($\phi_j$) and adjoint ($\phi_j^+$) solutions. The code accepts the $\phi_j$ and $\phi_j^+$ as punched by the VARI-QUIR program, and requires various other group constants, some of which are available from the GAM-TNS-RC program. This program was designed specifically for use in conjunction with the two above mentioned codes. The BETALS (and FAVELA) programs will be added to VARI-QUIR at a later date; this version is intended to provide a convenient way of calculating $\beta_{eff}$ and $l_p$ until then. The program listing includes many explanatory comments, for those who may wish to modify it to suit their own purposes. (auth)

**21721** (WANL-TME-1383(Rev.1)) NRX-A5 OPERATING LIMITS DOCUMENT. Hemmerle, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 28 Mar 1966. 27p. Dep. NTIS $4.50.

The constraints, within which NRX-A5 reactor operations prior to initial criticality will be accomplished, are defined. The operations involve receiving, inspection assembly, poison wire removal, transport to test cell "A" and checkout. Poison wire removal must be done with great care, a few at a time and with reactivity checks after each group withdrawal. (LTN)

**21722** (WANL-TME-1536) ADEQUACY OF TEST CELL C INSTRUMENTATION, DATA ACQUISITION, AND DATA REDUCTION SYSTEMS FOR NRX-A6 TESTING. Carl, C. E.; Wickas, L. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1967. 22p. Dep. NTIS $4.25.

The NRDS Test Cell "C" instrumentation, data acquisition and data reduction system is described as it now exists, with no major modifications anticipated (except filter additions for AC-coupled measurements). Based on all present reactor/test article measurement requirements, the present facilities are adquate for performing the NRX-A6 tests. The only minor exception to this would be the ability to accommodate all the presently required visual displays (Sanborn or console meter). In view of the fact that the discrepancy is small and no attempt has been made to optimize these requirements because of the present schedular allowance, the authors feel that no concern is warranted. (auth)

**21723** (WANL-TME-1556) TEST CELL C SYSTEMS DESCRIPTION DOCUMENT. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 Mar 1967. 404p. Dep. NTIS $23.25.

Twelve major Test Cell "C" (TCC) systems are described as they presently exist. TCC is undergoing modifications required for Phoebus testing and certain of these modifications are included. Descriptions of each system are intended to cover primarily the mechanical aspects of that system. An attempt has been made to restrict descriptions of modes of system operation, as they apply to NRX-A6, to only those necessary to aid in acquiring a basic understanding of how certain systems function in relation to others. Where such modes of operation are described, they should be considered typical and not considered to represent modes of operation for NRX-A6. (auth)

**21724** (WANL-TME-1560) JUSTIFICATION REPORT FOR NERVA SHIELD EXPERIMENT (NSX) RADIATION AND SHIELDING PROGRAM AT WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY (WANEF). Oblock, V. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1967. 90p. Dep. NTIS $7.50.

Regardless of the form that the nuclear space propulsion system may take, the effect of radiation from the reactor core on the structure, propellant operating mechanisms, and human beings, must be determined. Control of radiation levels in the propellant storage and engine area may be accomplished by a radiation shield located above the reactor core. It is desirable to minimize the weight of the shield since it is directly subtractable from the system payload during launch or at vehicle acceleration. To insure that the radiation fluxes at critical locations above the reactor do not exceed specified levels, and that shield weight is minimal, shield design and subsequent measurements of radiation levels must be done with high accuracy. Where two or more engine modules are clustered, the question of radiation levels becomes much more complicated because each engine receives direct radiation from the core of its neighbor and radiation back-scattered from other components. The general objectives of the proposed NSX radiation and shielding measurements with the NCX critical assembly facility are to reduce present uncertainties in calculations of radiation-induced heating rates in WANL components and the $LH_2$ tank, and in calculations of radiation fields internal and external to the reactor-engine system. The use of the NCX would provide a source of radiation with the proper spectrum to experimentally reduce the uncertainties such that the reactor, shield, engine components and propellant tank system will operate in a simulated space environment with a high degree of reliability. (auth)

**21725** (WANL-TME-1582) WANEF ANNUAL OPERATIONS REPORT, 1966. Thomas, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1967. 26p. Dep. NTIS $4.50.

The PAX-D reactor, continuing operation from 1965, was shutdown and disassembled on March 30, 1966. FCX was assembled and reached initial criticality on April 20, 1966. FCX was shutdown but not disassembled on June 6, 1966. PAX-E was assembled and attained initial criticality on June 23, 1966, and was still in operation at the end of the year. The experiments performed at WANEF on the PAX and FCX reactors included initial criticality, control drum worths, reactivity shimming, power distribution, reactivity coefficients of core and reflector materials, dosimetry measurements, reactor shutdown measurements by single drum withdrawal and pulsed neutron generator (PNG). Hazards analyses were performed on all experiments prior to initiation of the measurements. (auth)

**21726** (WANL-TME-1589) COMPARISON OF NRX AND XE-1 NEUTRONICS SAFETY SYSTEMS. Manion, J. R.; Starek, R. M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Mar 1967. 16p. Dep. NTIS $4.00.

A comparison of the XE-PRIME and NRX Neutronics Safety systems was made since they perform the same function in somewhat different fashions. The XE-PRIME system uses more reliable solid state amplifiers so, to compare the systems, it was compared to a hypothetical solid state version of the NRX system. Reliability figures of the same magnitude were found for both systems. (LTN)

**21727** (WANL-TME-1590) NRX/EST TRANSFER FUNCTION MEASUREMENTS BY TURBINE POWER CONTROL VALVE PERTURBATION AND COMPARISON WITH MODEL PREDICTIONS. James, L. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1967. 148p. Dep. NTIS $10.50.

The measured transfer function results obtained from the turbine power control valve (TPCV) perturbation experiment

conducted during the NRX/EST EP-IV test are presented. Included is a description of the pseudo-random TPCV perturbation test and transfer functions relating system pressures, turbopump speed, flow rates, temperatures and nuclear power to the turbine power control valve position. In addition, various component transfer functions of the reactor subsystem are presented. The quality of the measured transfer function data is discussed and cross-correlation techniques used in the processing of the data are presented. Each of the measured nuclear subsystem transfer functions are compared to post-test model predictions generated by a modified version of the Common Analog Model (CAM IIC). Transfer functions for the non-nuclear components of the system are included for completeness but no comparisons with the CAM model have been made. The primary objective of obtaining system and component transfer functions from the EP-IV pseudo-random perturbation test was met. A recommendation is made that additional tests be conducted by perturbing the TPCV with the pseudo-random signal in the XE series of tests. (auth)

**21728** (WANL-TME-1591) FEASIBILITY STUDY OF XE-1 ENGINE MOUNTED NUCLEAR DETECTOR (EMND-1A). Schatz, R. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Apr 1967. 51p. Dep. NTIS $5.75.

For reasons given a hold was placed on the concept of a propellant-cooled neutron detector, XE-1 EMND, and other designs favored. A feasibility study then showed that all requirements of a modified concept (EMND-1A) were realizable by state-of-the-art techniques, that all materials and components were available within the time and cost constraints, and at a cost comparable to that of other systems of equivalent performance, confidence and reliability. Interface changes are specified. (LTN)

**21729** (WANL-TME-1634(Suppl. 1)) NRX-A6 OPERATING LIMITS DOCUMENT. Hemmerle, E. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 31 Oct 1967. 13p. Dep. NTIS $4.00.

Constraints which are pertinent to safety and within which NRX-A6 reactor operations will be accomplished at the Nuclear Rocket Development Station (NRDS) are defined. The present supplement covers the reactor operation phase, non-run periods following initial criticality, return to the R-MAD Building following power operation and the initial steps of disassembly. The operating limits contained herein specify the administrative and technical boundaries within which these reactor operations will be performed. Operations subsequent to Post-Test Disassembly are subject to the limitations specified in the Criticality Control Manual. (auth)

**21730** (WANL-TME-1643) NON-NUCLEAR TESTING OF NERVA CANDIDATE PRESSURE TRANSDUCERS. Muha, R. J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Jul 1967. 51p. Dep. NTIS $5.75.

The results of the non-nuclear qualification tests performed on two WANL improved Wiancko 800 psia variable reluctance pressure transducers (WANL P/N 979D717 G01C) and three Statham 800 psia thin film strain gage pressure transducers (WANL P/N 979D718 G01B) are presented. The Wiancko transducer is a redesign of the Wiancko model 54726 (WANL P/N 945C923 H04D). The case has been opened on the new unit to allow reactor coolant to flow over the internal parts of the transducer. This significantly improves the heat transfer characteristics of the transducer and increases its capability to withstand gamma radiation heating. The Statham transducer was selected for evaluation on the basis of its minimal mass construction and good heat transfer characteristics. These two features should make it capable of operating in a gamma radiation environment. The non-nuclear performance of the Wiancko and Statham transducers was determined acceptable for evaluation type units. In most cases, both transducers designs performed reasonably within the specified limits of WANL E-675576. This specification is used for procuring qualified transducers for use on the NERVA reactor. It was used in these evaluation tests primarily as a guideline. No serious operational difficulties are anticipated, and both transducer types merit nuclear evaluation testing and further development work. (auth)

**21731** (WANL-TME-1690) PLAN FOR TEST CELL 'C' ACCURACY STUDY. Step II. Jones II, G. S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Oct 1967. 24p. Dep. NTIS $4.25.

A test of the Test Cell "C" narrow band data acquisition system is planned, somewhat similar to that performed on the Test Cell "A" data acquisition system some years ago. The tests are designed to study overall channel accuracy, linearity, drift, noise, frequency response, crosstalk, to compare multiplexer types and to detect any anomalous results. (LTN)

**21732** (WANL-TME-1716) TEST CELL 'C' ACCURACY STUDY. Phase I Results. Jones, G. S. II; Horton, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Nov 1967. 19p. Dep. NTIS $4.00.

In conjunction with the Phoebus 1B-EP10A test run, several data acquisition system calibration runs were made with the test Cell "C" narrow band system. The Test Cell "C" system is quite similar to that for Test Cell "A" for which an extensive accuracy study was completed in 1965. Because of the similarity, complete study for Test Cell "C" was unwarranted, but some study was needed to demonstrate the similarity and to ascertain whether or not there are any inconsistencies between the two cells. The test plan used to sample the Phoebus 1B calibration data is presented with a brief discussion of the sampled data and their analysis, and the results and conclusions derived from the analyses of the data for this study. (auth)

**21733** (WANL-TME-1737) XE-1 PNEUMATIC ACTUATOR FAILURE MODE ANALYSIS. Spezialetti, I. R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 11 Feb 1968. 31p. Dep. NTIS $4.75.

The XE-1 Pneumatic Actuator Mechanism is a hydrogen gas driven servo subsystem designed to rotate the control drums of the XE-1 reactor. Each of twelve pneumatic actuators is connected mechanically to a control drum assembly. Each control drum assembly is equipped with a relatively strong "Scram" spring which functions to rotate the actuator toward the decrease reactivity direction, both under normal and scram conditions. The actuators power the control drums in the increase reactivity direction only, and function to limit the rate of control drum rotation in the decrease reactivity direction, caused by the force of the scram spring. A failure mode analysis found no failure mode producing a critical or hazardous condition. Some failures could result in a degradation of performance and problems encountered in using the actuators were corrected to prevent potential difficulties, even though their actual effects were insignificant in most cases. (LTN)

**21734** (WANL-TME-1740) WANL CHECKOUT PROCEDURES, WANL SUPPLIED EQUIPMENT, TSCS/ECS-ETS-1. Brinda, J.; Merchant, C. C. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1968. 52p. Dep. NTIS $5.75.

Procedures are given for checking out at the systems level such nuclear subsystem controls as nuclear instrumentation, reactor control systems, reactor safety system, etc. This equipment should already have been checked at the chassis level. Interfacing equipment is not included. (LTN)

**21735** (WANL-TME-1741) ERROR BAND LIMITS FOR WANL MEASUREMENTS ON XE-1. Moran, M. J.; Wolsko, T. F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1968. 123p. Dep. NTIS $9.25.

Overall error band limits for the expected accuracies of all Westinghouse-supplied transducers used in the XE-1 Test Series have been calculated. The overall error is the root-mean-square combinations of the transducer error (taken during calibration) and the data system error. The confidence level is near 99 percent, but in some cases the number of samples was not quite large enough. The curves were prepared by using the UNCERT program with the CDC-6600 computer and the CAL COMP plotter. (LTN)

**21736** (WANL-TME-1949) NSS STARTUP AND SHUTDOWN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Jun 1970. 18p. Dep. NTIS $4.00.

An evaluation of the NSS for the selection of the mode of reactor startup and shutdown has been made. The objective was to analyze performance and the effects on design and establish a recommendation of the mode of startup and shutdown based upon these analyses. Three modes of startup, two modes of shutdown, and three different rates were considered. Two of the modes were the high specific impulse and high thrust start-ups specified in the NPRD-1 and the third was a middle of the map startup. One method of shutdown at three different rates was evaluated. The evaluation of the effects of startup on the NSS resulted in the recommendation that the middle of the map startup and shutdown mode be adopted as the one and only startup requirement imposed on the design. This recommendation is based on the fact that no major advantage could be identified for either the high specific impulse or high thrust startup over the middle of the map mode, and the high specific impulse and high thrust startup modes have several significant NSS disadvantages or penalties related to reliability, reactivity span, control complexity, safety, component constraints and limitations, etc. (auth)

**21737** (WANL-TME-1952) PARX2 DATA SYSTEM USERS MANUAL. Jacob, B. J.; Hill, R. (Westinghouse Electric Corp.,

Pittsburgh, Pa. (USA). Astronuclear Lab.). Feb 1970. 202p. Dep. NTIS $13.25.

Data reduction for reactor shield tests conducted at Waltz Mills is accomplished by the PARX2 Data System. This system consists of a CDC-6600 SYSTEM SORT and four computer programs: PARX2, PARX21, DIRECT, and PARX22. The function of each program, the computer input required, Fortran listings, sample output, and the deck setup for execution of the programs are described. (auth)

**21738** (WANL-TME-1957) SATS: A COMPUTER PROGRAM FOR PLANE THERMAL STRESS ANALYSIS BY SERIES SOLUTION. Swanson, J. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1971. 168p. Dep. NTIS $11.50.

A two-dimensional thermal stress computer program, which calculates the stresses and deflections for problems of plane stress or plane strain is described. This program, called SATS (Series Analysis of Thermal Stress), is based on earlier work of Dr. L. E. Hulbert. It calculates the temperature and stress fields for plane two-dimensional bodies with boundary conditions including prescribed displacements, surface pressures, temperature and convective boundary conditions. The solution is obtained by "best-fitting" a truncated series solution of the harmonic equation to the defined temperature boundary conditions and a truncated series solution of the biharmonic equation to the defined stress or displacement boundary conditions. Included is a description of the required input data for the SATS program and a contour plotting program which will yield contour plots of the stress and temperature results, an example problem illustrating the application of the program to a simple thermal stress problem, and a listing of the SATS program and the plotting program. SATS is written in FORTRAN IV for the CDC 6600 computer. A core size of $135000_8$ is required. (auth)

**21739** (WANL-TME-1966) PRODUCT ASSURANCE PROGRAM PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jul 1970. 65p. Dep. NTIS $6.25.

"The NERVA Engine shall be man rated. Equipment is man rated when its utilization in manned space vehicles provides for and protects the crew's well being and utilizes man's ability to control and repair. It follows that man rated equipment, and especially propulsion, must be highly reliable. Man rating is not attained solely by compliance with some particular specification or rule. Rather it results from that fastidious approach to the total effort from concept to final disposition in flight which takes every reasonable step to assure the safety of the astronauts, the launch crew and the general public. Special steps are required to assure the elimination of errors and, in particular, errors caused by the use of "engineering judgment" by individuals during design, test or fabrication. To give visibility to the use of judgment, special procedures and approaches will be devised to assure that the judgments do not stand unreviewed." More than 50 other documents are referenced as applicable in carrying out the product assurance program. (auth)

**21740** (WANL-TME-2000) NERVA CONFIGURATION MANAGEMENT PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 58p. Dep. NTIS $6.00.

Westinghouse Astronuclear Laboratory's (WANL) Configuration Management (CM) Program will provide a set of formal procedures which will, as a minimum, satisfy the three fundamental objectives (configuration identification, configuration control, and configuration accounting) of AFSCM 375-1. A set of data items, in general conformance with AFSCM/AFLCM 310-1; will be provided for the customer's review and approval which will, in detail, identify the configuration of systems/equipment under development, tests, and production in support of, and for, the WANL Contract End Items (CEI's). A Change Control System will be implemented to review, approve/disapprove, and submit to Aerojet General Corporation (AGC) for approval, all changes to approved baselines. An Accounting System will be implemented and maintained which will, as a minimum, assure that the software at all times will accurately reflect the hardware status. A set of interface control documents will be (in consonance with AGC) maintained to assure proper interfacing between NERVA Program CEI's. In the event of conflict between this plan and subcontract NP-1, the contract requirements shall govern. The WANL NERVA Program Manager has the responsibility for the issue and approval of this plan and all subsequent changes thereto. (auth)

**21741** (WANL-TME-2657) WORK PROGRAM. Westinghouse Astronuclear Laboratory NERVA nuclear subsystem. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 6 Feb 1970. 136p. Dep. NTIS $10.00.

Detailed projects and tasks for the WANL Contracted work program for the 1970 contract year are presented. (LTN)

**21742** (WANL-TME-2689(Vol.1)) EVALUATION OF THE WANL INTEGRATED NUCLEAR, RADIATION, AND SHIELDING STANDARD DESIGN METHOD (WISDM). (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Sep 1970. 320p. Dep. NTIS $19.00.

The WANL Integrated Nuclear, Radiation and Shielding Standard Design Method (WISDM) used in nuclear and radiation design and analysis of the NERVA Nuclear Subsystem is described. An evaluation of the accuracy of the WISDM methods and techniques is made by comparison with experimental results. WISDM is an integral part of an overall Design Engineering Method being developed to automate the mechanical, thermal, structural, nuclear, and radiation analyses and design of the NERVA Nuclear Subsystem. Methods related to predictions in the following nuclear, radiation, and shielding analysis areas are discussed: (1) absolute reactivity (for component sizing or fuel loading), (2) control drum worth, (3) fission distribution (for fuel zoning or coolant allocation) (4) material reactivity worth (for evaluation of the effect of non-nominal compositions or conditions), (5) shield performance, (6) radiation heating rates (for component cooling requirements), and (7) radiation environment (for radiation damage). (auth)

**21743** (WANL-TME-2714) USE OF THE NERVA REACTOR AS THE HEAT SOURCE FOR A SPACE PROPULSION/ELECTRICAL POWER SYSTEM. Lee, W. H. Jr.; McCutchan, D. A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1970. 88p. Dep. NTIS $7.50.

The feasibility of using the nuclear subsystem (NSS) in dual-mode operation is investigated. After completing its propulsion usage, the NSS will be used as the heat source for a twenty-five kilowatt electrical generation system. The NSS thermal and fluid-flow capabilities and limits in the electrical generation mode are identified, and fuel burnup, fission product buildup, and changes in control requirements are estimated. The nuclear subsystem offers two possible heat-removal methods: utilization of the support stems, and utilization of flow passages in the reflector area. The use of support stems initially appears feasible for power levels to almost 500 kW, but analysis shows leakage during the eight-year period requires a replenishment of the working fluid on the order of a million pounds. Tubes on the periphery of the reflector eliminate leakage and seem to be feasible solutions utilizing the reflector area for heat removal, but the required temperature gradients cause core temperatures to exceed acceptable levels, limiting heat removal to about 80 kW. Use of the aluminum reflector barrel, though limited to 200-250 kW in heat removal capability, seems to provide a technically-feasible design solution. The selected concept separates the propulsion-mode flow path from the electrical-generation-mode flow path and offers the best dual-mode reliability and least propulsion-mode interference. Detailed studies are required of the thermal and structural characteristics of components which do not directly interact with the coolant fluid during the electrical generation mode as well as those which have direct contact with the fluid. The impact on reactor control modes to achieve the required high reliability must be assessed. The increase in the thermal impedance to heat transfer to the electrical mode fluid path under hard-vacuum operation must be evaluated. After confirmation of the concept's feasibility by detailed studies, consideration should then be given to its incorporation into the NSS reference design. (auth)

**21744** (WANL-TME-2766) MAINTAINABILITY ALLOCATIONS ASSESSMENT AND ANALYSIS REPORT NUCLEAR SUBSYSTEM. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jan 1971. 114p. Dep. NTIS $8.75.

The maintainability features of the Nuclear Subsystem of the NERVA engine are presented. It provides an evaluation of the current and potential maintainability of the NSS for meeting the specified requirements. (auth)

**21745** (WANL-TME-2779) WESTINGHOUSE ASTRONUCLEAR EXPERIMENTAL FACILITY. Annual Operations Report, January 1970–March 1971. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Mar 1971. 25p. Dep. NTIS $4.25.

Capsule descriptions of the reactor operations carried out on PAX and FCX during the period 1/70 to 3/71 are given with references to documents on the experimental results. Also included is a description of the new site alarm system, revised safety documentation, fuel handling activities and training of personnel. Due to a reduction in funds, the critical assembly cores have been taken apart and the facility placed on standby. (auth)

**21746** (WANL-TME-2793) MODIFICATIONS OF CASCADE-CASING AND RESULTS OF CALCULATIONS. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Jun 1971. 82p. Dep. NTIS $7.25.

A number of new options have been added, and improvements made to the original CASCADE-CASING codes. These changes are described. Modified input instructions and results of calculations for some elements of interest to the NERVA project are also presented. (auth)

**21747** (WANL-TMI-364) NRX-A1 CORE SUPPORT LATERAL SHOCK SPRING. Villasor, A. P. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Oct 1962. Dep. NTIS $4.00.

A non-metal shock spring, using disks of graphite cloth (Grade WCB, National Carbon Company) stacked in a cylindrical container is shown by static tests to duplicate the desired performance characteristics. Fraying of the cloth disks is noticeably less than that experienced with tightly confined rolled cloth. (auth)

**21748** (WANL-TNR-054) MAXIMUM FUEL TEMPERATURE WITH ONE COOLANT CHANNEL BLOCKED. Boman, L. H. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 19 Mar 1962. 8p. Dep. NTIS $4.00.

For a solid heat-generating core with parallel coolant channels, the maximum fuel temperature is of paramount interest. This study provides an estimate of the effect of hole blockage on this maximum temperature for a triangular array. In order to obtain an upper limit on fuel temperature for the case in which a flow hole would become blocked in the triangular array, the temperature distribution for a hexagonal array was derived. This was accomplished by the simple superposition of two triangular array distributions for which a solution was available. The maximum hexagonal array temperature is a conservative maximum to use for a triangular array with one blocked hole. (auth)

**21749** (WANL-TNR-088(Rev. E.)) PRODUCT ASSURANCE PROGRAM PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 22 Aug 1966. 339p. Dep. NTIS $20.00.

The Nuclear Subsystem of the NERVA engine must meet high standards of reliability and safety. The methods by which problems will be identified and reliability insured are detailed. The basic responsibility rests with the designers but everyone must share in ensuring that the reliability inherent in the design is realized. (LTN)

**21750** (WANL-TNR-127) DESIGN MANUAL AND HAZARDS ANALYSIS FOR EXPERIMENT NO. 40/W004, CONTROL DRUM BEARINGS AT PLUM BROOK REACTOR FACILITY (RF1, 63-05). Cadoff, H.; Newby, D. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 18 Dec 1963. 10p. Dep. NTIS $4.00.

This experiment involves the irradiation testing of two control drum bearings and a retainer ring under the environmental conditions in the W-2 Loop of the HT-1 in the Plum Brook Reactor Facility. The cooling, control, and instrumentation system described in WANL-TNR-119 remains the same. Most hazards and emergency contingencies are less than those considered in WANL-TNR-119. The activations expected from the irradiation are calculated. (LTN)

**21751** (WANL-TNR-168) NRX-A2 OPERATIONAL SUPPORT PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Jul 1964. 142p. Dep. NTIS $10.25.

**21752** (WANL-TNR-169) NRX-A3 OPERATIONAL SUPPORT PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 1 Aug 1964. 150p. Dep. NTIS $10.50.

**21753** (WANL-TNR-190) NRX-A4 OPERATIONAL SUPPORT PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 30 Dec 1964. 132p. Dep. NTIS $9.75.

**21754** (WANL-TNR-201) NERVA PROGRAM NRX-A5 TEST PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Aug 1965. 21p. Dep. NTIS $4.25.

The overall objective of the NRX-A5 test series is to evaluate or demonstrate the capability of the test assembly to operate in accordance with predicted performance during attainment of the following test goals: To operate at design conditions for a total time of 40 minutes, to start up and shut down at chamber temperature transients up to ±150°R/sec, to operate the reactor utilizing new control concepts, to start up from source power to full power and shut down on liquid hydrogen flow with constant drum position, to operate at extremes of the steady-state operating map for a range of conditions up to and including rated conditions, to cool the reactor using $LH_2$ cooldown techniques following sustained full power operation, and to obtain transfer function measurements during operation at several selected power levels. (auth)

**21755** (WANL-TNR-203) NRX-A5 OPERATIONAL SUPPORT PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). [nd]. 133p. Dep. NTIS $9.75.

The functional operations that must be performed to complete each step of an individual NRX-A5 reactor test and the equipment required to accomplish each operation are listed in chronological sequence. Included are the operations and support equipment required in the packaging and shipment of the non-nuclear components, the packaging and shipment of the reactor/vessel, the receiving of components, integration of components, preparation for testing, hot disassembly, and post/operative examination at the Nuclear Rocket Development Station (NRDS) at Jackass Flats, Nevada, the disposition of components, and the post-operative examinations at other facilities. (auth)

**21756** (WANL-TNR-212) NERVA PROGRAM NRX-A6 TEST PLAN. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Apr 1966. 12p. Dep. NTIS $4.00.

Overall plans for the NRX-A6 Test Series are outlined briefly. It is planned to run the reactor at full power for one hour, and to evaluate performance in the start-up and operating regions and control of systems in particular (aiming for simple, reliable control methods with stable operation over the range needed). The flow and instrumentation systems will also be evaluated. (LTN)

**21757** MONTE CARLO DEVELOPMENT AND APPLICATIONS IN THE LOS ALAMOS NUCLEAR ROCKET PROGRAM. Watson, C. W.; Cashwell, E. D. (Los Alamos Scientific Lab., NM). pp 166-185 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The history of Monte Carlo use in the Rover Nuclear rocket program at LASL is traced. The type of problems requiring Monte Carlo solutions and specific applications are discussed, the latter to show how need led to development and to illustrate capabilities. A synopsis of present codes, code characteristics, and available tally options is included. Of principal interest have been radiation environmental calculations for the Rover reactor-testing program. Recent emphasis, however, has been upon Monte Carlo criticality calculations. Data from experimental studies conducted explicitly to assess Monte Carlo results are presented and discussed. Monte Carlo criticality results are also compared with experiment. Plans for the extension of Monte Carlo capabilities are outlined. (FR)

**21758** DEVELOPMENT OF CALCULATION METHODS AND CODES AND THEIR APPLICATION TO SPACE REACTOR SHIELDING. Amin, E.; Hehn, G.; Klumpp, W.; Ruehle, R. (Univ., Stuttgart). pp 396-408 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

For simplifying the handling of different reactor and shielding programs with large data input and output the modular program system RSYST has been developed which works with a central data pool from which the individual module gets all data and writes the results back. For two-dimensional deep penetration problems a special $S_N$-procedure is recommended which overcomes the ray effect by applying first collision correction together with local separation technique. An optimization method using dynamic programming was developed for space reactor shielding. (FR)

**21759** STUDY ON SHIELDING EFFECT OF GAMMA RAYS BY SHIP STRUCTURE. Ueki, K.; Yamakoshi, H.; Nakata, M. (Ship Research Inst., Tokyo). pp 1166-1182 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The compartment structure of a ship is considered as being composed of finite-sized iron slabs with various shapes and sizes. An empirical formula is proposed for estimating the energy buildup factor for finite dimensions iron slabs on the positions of the $\gamma$ source and detector, the energy of the $\gamma$ source and detector, the energy of the $\gamma$ source and geometry of the iron slab. A formula is proposed for predicting the energy buildup factor for $\gamma$ rays at arbitrary positions within a compartment structure, in terms of geometry of the structure and the energy buildup factor for each iron slab of finite size. The energy buildup factors predicted with conventional calculation methods and the proposed method are compared with the experimental results for a model of compartment structure. The method is shown to improve the prediction by taking account of the shielding effect of the compartment structure against $\gamma$ radiations. The method is applied to an analysis of the dose

distribution of γ rays in a training ship the Shintoku Maru to show that it works well. (FR)

**21760** SHIELDING CHARACTERISTICS OF A NUCLEAR POWERED MANNED SPACE STATION. Keshishian, V. (North American Rockwell Corp., Canoga Park, CA). pp 186-187 of Fourth International Conference on Reactor Shielding. Paris; Eyrolles ([nd]).

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The use of nuclear power for manned space stations is very attractive for missions of long duration. For space stations requiring a large shield cone half angle, the shield weight may be minimized by placing the radioactive primary loop equipment around the reactor radial shield. The selection of shield materials was based on a minimum weight shield, and on engineering and safety constraints. In arriving at the final shield design, various operational constraints, such as rendezvous dose and flyby dose, were considered. For the thermoelectric and Brayton systems, the reactor thermal power was 680 and 127kW(t) respectively, and the corresponding shield weights were 13,000 and 8,900 lb. (FR)

**21761** NEW STATUS OF SPACE NUCLEAR PROPULSION IN THE UNITED STATES OF AMERICA. Gabriel, D. S.; Helms, I. (Atomic Energy Commission, Washington, DC). At. Energy Rev.; 12: No. 4, 801-836(Dec 1974).

The status is reviewed of development of several advanced nuclear space propulsion methods in the United States of America such as the solid core nuclear rocket and the thermionic reactor intended for use in ion-propulsion. The ramifications of some more advanced propulsion methods such as the dust bed and gaseous core reactors, fusion-electric rockets, and photon rockets, potential mission applications of advanced propulsion, and the propulsion system advances that would be necessary for man to be able to operate freely in the near-to-earth solar system, in the extremes of the solar system, and in extra-solar space are discussed. 14 references. (auth)

# Reactor Safety and Environmental Aspects

*Refer also to abstracts 19324, 19363, 19511, 19545, 19548, 19551, 19552, 19556, 19557, 19561–19563, 19565, 19568, 19574, 19579, 19588, 19670, 19677, 19678, 19681, 19951, 19974–19976, 19979, 19980, 20004, 20071, 20072, 20074, 21288, 21835, 21867, 21885, 21886, and 21900.*

**21762** (74-ANC-600, pp 11) THE CITIZEN OF QUEBEC AND NUCLEAR ENERGY. Roch, S. Y. 1974. (In French).

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 6. Nuclear energy and the public.

The author worked for the public relations department of Atomic Energy of Canada Limited, during the summers of 1972 and 1973, touring Quebec with a travelling exhibition. In general, the public is in favor of nuclear energy. They seemed to better informed about it in 1973 than in 1972. Although some members of the public did not seem to know any difference between Canadian and foreign systems, many intelligent questions were asked about economic aspects. (INIS)

**21763** (AED-CONF-74-496-001) TECHNICAL-PHYSICAL MODELS OF EXTERNAL IMPACTS AND DERIVATION OF LOAD AND STRESS DATA. Drittler, K. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). 1974. 37p. (In German). (CONF-741075-3). INIS.

From meeting on protection of nuclear power plants from external impacts; Koeln, F. R. Germany (30 Oct 1974).

With abstract in German and English.

Following a general discussion of the quantitative assessment of external effects, calculations on the consequences of earthquakes, shockwaves from explosions and airplane crashes are dealt with in detail. These effects are of specific importance because of their influence on the design of nuclear power plants. After general details, the time-course and answer-spectrum methods, procedures to calculate earthquake effects, are discussed. Then, the specification of design earthquakes is described. In doing so, special emphasis is given to the practice applied in the Federal Republic of Germany. As a basis of a deflagrating gas cloud model, general explosion characteristics are given. Calculation steps and results of the gas cloud model are presented and effects of shockwaves on buildings are discussed. In case of airplane crashes, calculation models are explained covering the airplane as a whole. Thereafter, formulas are presented to calculate the protective effect of the wall thickness against penetration. Dropping airplane debris, without regard to their distribution, may be treated like an airplane as a whole. Finally, minimum spacing or depth requirements for underground cables are discussed. (auth)

**21764** (AED-CONF-74-496-004) RESEARCH WORK CONCERNING THE PROBLEMS ASSOCIATED WITH EXTERNAL IMPACTS. Pfeiffer, A. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). 1974. 14p. (In German). (CONF-741075-5). INIS.

From meeting on protection of nuclear power plants from external impacts; Koeln, F. R. Germany (30 Oct 1974).

With abstract in German and English.

The program External Events is divided into three parts within the framework of the Reactor Safety Research Program: earthquake, airplane crash and gas explosion. Some main experiments are: shaking experiments for earthquake simulation at the superheated steam generating reactor (HDR) and building of a big acceleration facility, which can be used for throwing missiles against wall models. Within the region of gas explosions experiments are conducted by means of balloons and blast tubes to study pressure wave propagation and reflection. (auth)

**21765** (AED-CONF-74-496-005) HAZARDS TO NUCLEAR POWER PLANTS DUE TO EXTERNAL IMPACTS. Suetterlin, L. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V., Koeln (F. R. Germany)). 1974. 10p. (In German). (CONF-741075-2). INIS.

From IRS expert discussion meeting: protection of nuclear power plants from external impacts; Koeln, F. R. Germany (30 Oct 1974).

With abstract in German and English.

Assuming that the safety of nuclear power plants against plant internal disturbances is based on sound functioning of a sufficient number of redundant and diverse safety measures, then the external impacts, become a common mode failure problem. This calls for an enhancement of safety measures. Following the schematic representation of the safety philosophy a general description of the implications of earthquakes, pressure waves and aircraft impacts will be given. Finally, these individual incidents will be given the forms of concrete forces, with the implied aim to achieve a thorough general conception for the protection of nuclear power plants from external impacts. (GE)

**21766** (ANL-8118) CSDT SIMULATION MODEL FOR PREDICTION OF IHX TRANSIENT BEHAVIOR USING S/360 CSMP. Brukx, J. F. L. M. (Argonne National Lab., Ill. (USA)). Aug 1974. Contract W-31-109-eng-38. 86p. AT.

A digital simulation model to predict the transient behavior of sodium-to-sodium counterflow heat exchangers is described. The model is programmed for an IBM S/360 Model 75 computer using the S/360 Continuous System Modeling Program (CSMP) as the basic programming tool. The equations of the mathematical model are solved through use of the serial or Continuous-space/Discrete-time (CSDT) method; the nature of the problem thereby requires an iterative solution search for each instant of time. Axial temperature distributions of sodium and tube-wall surface are obtained at every time step. It is found that CSMP provides a convenient means for implementing the simulation when certain extensions and modifications to standard usage are used. Results that illustrate model capabilities and matters of computational efficiency are presented for two sample intermediate heat exchangers (IHX's). (auth)

**21767** (ANL-8155) FRAGMENTATION OF MOLTEN MATERIALS DROPPED INTO WATER. Cho, D. H.; Gunther, W. H.; Armstrong, D. R. (Argonne National Lab., Ill. (USA)). Dec 1974. Contract W-31-109-eng-38. 22p. Dep. NTIS $4.00.

A series of experiments were performed to investigate the fragmentation of a hot molten material in a cold quench liquid. Small quantities of various molten materials (less than 1 g) were dropped into a pool of water and the projected areas of the resulting fragments were measured for the extent of fragmentation. Five materials having low melting points were used in this investigation: tin, bismuth, silver chloride, zinc and lead. In most cases, the dropping distance was kept constant at 2 in. from the water surface while the temperatures of the molten samples and water were varied over a wide range. (auth)

**21768** (BAW-10069-A(Rev. 1)) RADAR: REACTOR THERMAL AND HYDRAULIC ANALYSIS DURING REACTOR FLOW COASTDOWN. Morgan, C. D.; Cheatwood, H. C.; Gloudemans, J. R. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Oct 1974. 100p.

The RADAR digital computer program performs a thermal analysis of a slow reactor transient such as the loss of a primary pump. The code computes, as a function of time, fuel pin temperatures, cladding surface temperatures, critical heat flux ratios, and coolant thermodynamic conditions when given the fuel pin heat rate and either the channel flow or pressure drop as a function of time. Because of the restriction to slow transients, RADAR requires very little computer time to analyze a typical problem. The run time for a typical case is 0.6 second per axial node per time step. Since the solution technique is implicit, there is no stability limitation on the size of the time increment. (auth)

**21769** (BAW-10082(Pt.1)) SEISMIC QUALIFICATION METHODS. Part 1. Ertel, R. G. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Jan 1975. 31p.

The seismic qualification program for control and instrumentation equipment is described. Equipment descriptions, hardware interface requirements, test procedures, analytical requirements, and documentation requirements are presented. (JWR)

**21770** (BAW-10091(Supp.1)) SUPPLEMENTARY AND SUPPORTING DOCUMENTATION FOR B AND W's ECCS EVALUATION MODEL REPORT WITH SPECIFIC APPLICATION TO 177-FA CLASS PLANTS WITH LOWERED-LOOP ARRANGEMENT. Dunn, B. M.; Cartin, L. R.; Jones, R. C. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Dec 1974. Vp.

Information is presented in support of the B&W ECCS Evaluation Model. Responses to a broad range of AEC questions (Question Sets 1 through 43) on BAW-10091 are provided. The impact of AEC-identified model "patches" and information on additional model changes are included. The AEC questions have been grouped into specific categories and are numbered in sequence. The index, section 6, correlates the questions contained herein with the AEC Question Sets. (auth)

**21771** (BAW-10092(Rev. 1)) CRAFT2: FORTRAN PROGRAM FOR DIGITAL SIMULATION OF A MULTINODE REACTOR PLANT DURING LOSS OF COOLANT. Revision 1. Hedrick, R. A.; Cudlin, J. J.; Foltz, R. C. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Dec 1974. 37p.

**21772** (BP-TOP-1(Rev.2)) SEISMIC ANALYSIS OF PIPING SYSTEMS. (Bechtel Power Corp., San Francisco, Calif. (USA)). Jan 1975. 59p.

The seismic analysis of Seismic Category I piping systems reflecting present Bechtel practice is described. Response spectrum method is the computational technique used in the analysis. The analytical procedures for rigid and flexible piping systems are discussed. In addition, some simplified analytical approaches are also included. All Atomic Energy Commission concerns relative to seismic analysis of piping systems have been addressed. (auth)

**21773** (DRAM-9) RELIABILITY TECHNIQUES: DATA, METHODS, APPLICATION. Example of Application in Nuclear Power. Dahll, G.; Hansen, O. (Det Norske Veritas, Oslo; Trondheim Univ. (Norway). Institutt for Skipsmaskineri; Scandpower A/S, Oslo (Norway); System for Drift av Skip, Oslo (Norway)). 1973. 55p. (In Norwegian). Dep. NTIS (U. S. Sales Only) $5.50.

An example of reliability analysis of a core-spray system in a BWR is presented. A description of the barriers which prevent the radioactive materials in the core from being released to the environment forms an introduction. The cooling systems which have to be operative for the barriers to be intact are also described. The method of cause-and-consequence seeking is applied to determine which of the cooling systems is of greatest importance should an accident, of the kind which is described, occur is a nuclear power plant. This system is then analyzed in more detail. The system analysis starts with a definition of the various circuits in the system. Component lists and flow diagrams are used in the functional description of the system. Based on these, two fault trees, one for the starting period of the system and one for the long term cooling, are drawn. These are used in the computer programs REPRO, based on analytical methods, and MCREL based upon simulations. The failure and repair data used in the calculation of the system reliability, are collected from the best available sources. Based on these data and the fault trees the reliability calculations are performed. A point is made of showing how the two programs can be applied to a concrete example. It is pointed out under which circumstances the one or the other of the two programs is the most suitable, and how the results from REPRO can be used to speed up the simulation in the MCREL program. (auth)

**21774** (EURFNR-1156) SODIUM EXPERIMENTS FOR THE INVESTIGATION OF LOCAL COOLING DISTURBANCES IN TEST ASSEMBLIES SIMILAR TO FUEL ELEMENTS. Schleisiek, K. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorentwicklung). Feb 1974. Translation of KFK-1914. 72p. Dep. NTIS $5.45.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Local coolant disturbances in fuel elements of sodium cooled fast reactors are of major importance to reactor safety. Since the experimental investigation of such disturbances in full scale bundles of high performance electrical heaters will be possible only in a few years time, preliminary experiments were performed in a simpler test assembly. The temperature distributions measured behind the test assembly blockage are subjected to a detailed analysis. A semi-empirical convection model is developed which approximately describes the relationship between the increase in temperature, the residence time of the coolant in the recirculation zone behind the blockage, and the size of the blockage. The comparison of the measurements performed with water and sodium under the same conditions proves that with blockages of the size investigated the energy transport is controlled more by convection than by any other transport mechanism. Accordingly the temperature distributions measured can simply be converted to sodium. Application of the model to SNR fuel elements shows that the increase in temperature generated by major blockages (>40%) is probably lower than has so far been assumed. In the boiling experiments it was found out that local boiling is a single-bubble process. Despite the turbulent recirculating flow considerable incipient boiling superheat is possible the magnitude if which having a major influence upon boiling. 49 references. (auth)

**21775** (GEAP-13923-5) SAFETY ENGINEERING. Fifth Quarterly Report, August–October 1973. (General Electric Co., Sunnyvale, Calif. (USA). Advanced Technology Dept.). Nov 1973. Contract AT(04-3)-893. 32p. AT.

The purpose of the Safety Engineering Task (TA 893-2) is: (1) to bring into sharp focus both the requirements for specific technical information related to LMFBR safety, and the results of previous studies, wherever performed; (2) to recommend to AEC-RRD a course of action which will provide the information still required. The existing LMFBR national safety development program includes both analytical and experimental programs. The Safety Engineering Task utilizes the results of these programs to evaluate their applicability to LMFBR conditions. This goal is obtained by direct use of nationally developed accident-analysis codes and by active participation in the evaluation of safety-related experimental data through both: (1) round-robin analyses of current experimental tests involving ANL and HEDL; (2) independent review and analysis of existing experimental tests. The results of these activities are in the form of correlations of existing data and recommendations on future directions for safety development experimental programs. 55 references. (auth)

**21776** (HWS-8730) SPECIFICATIONS FOR CONFINEMENT SYSTEM CHARCOAL FILTERS. Etheridge, E. L.; Mecca, J. E. (Douglas United Nuclear, Inc., Richland, Wash. (USA)). 8 Jan 1969. 7p. Dep. NTIS $4.00.

Fabrication specifications and requirements of activated charcoal filters for use in nuclear service are presented. Performance testing, inspection, and handling requirements and procedures are also specified. (DG)

**21777** (JAPFNR-175) ANALYTICAL CODE "PICO" FOR FUEL PIN CONTACT ACCIDENT. Ohtsubo, A. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jul 1974. 36p. (PNC-N-241-74-08). Dep. NTIS (US Sales Only) $5.00.

Work performed under United States–Japanese Fast Reactor Exchange Program.

The analytical code "PICO" was developed for calculation of temperatures of cladding tubes at such contact points where two fuel pins may accidentally contact with each other inside the FBR core fuel assembly. This analytical code is based on the multi-flow channel thermal hydraulic analytical code "HECTIC-II." (auth)

**21778** (JUL-1112-RG) TEMPERATURE BEHAVIOR OF A HIGH-TEMPERATURE REACTOR AFTER FAILURE OF THE TOTAL COOLING. Lukaszewicz, J. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). Oct 1974. 110p. (In German). Dep. NTIS (U. S. Sales Only) $8.50.

Thesis. Submitted to Technische Hochschule Aachen, West Germany.

The behavior of a high-temperature reactor in the case of the total cooling failure is investigated for the process heat reactor PR 500 as an example. Under the assumption that all cooling systems including the emergency cooling fail and that a shutdown of the reactor immediately occurs, the time dependent tempera-

ture curve, resulting by afterheat production, is calculated for the whole reactor. In the case of an undamaged primary circuit and full cooling gas pressure, the calculations show that the afterheat can be removed by natural convection. When the coolant is stagnant, the whole afterheat has to be taken up by the reactor core. But even in this most unfavorable case the fuel elements are not endangered. (auth)

**21779** (KFK-2036) SOME CONSIDERATIONS ON THE DEVELOPMENT OF A CORE CATCHER OF A GAS COOLED FAST REACTOR. Barleon, L.; Donne, M. D.; Dorner, S. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Feb 1974. 25p. (EUR-4977e; CONF-740239-1). Dep. NTIS (US Sales Only) $4.25.

Short-time transient calculations indicate a core-melt interface temperature of 1385°K for a graphite catcher and 1470°K for a steel catcher. The relatively slow instationary processes produced by the decay heat are considered as quasi-stationary, and temperature distributions are calculated for various power densities. For the calculation of the stationary temperature and heat flux distributions, natural convection is assumed to be fully established, and solid and liquid layers are assumed to be formed according to the temperature profile. The convection in the layer with natural convection is given by many little vortices (Bernard cells). For such a configuration calculations of the temperature differences of the boundary layers indicate that the formation of two layers of oxide fuel, one solid and one of stagnant liquid respectively, permits only a small portion of the decay heat to be absorbed by the core catcher. The possibility of using graphite as core catcher constituent material is examined. Two types of emergency cooling are investigated: dry cooling, without the introduction of a supplementary coolant, and wet cooling, with the introduction of a supplementary liquid coolant, such as a molten salt. (auth)

**21780** (ORNL-TM-4727) LMFBR SAFETY AND CORE SYSTEMS PROGRAMS PROGRESS REPORT FOR APRIL–JUNE 1974. Fontana, M. H.; Wantland, J. L. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 83p. AT.

Progress is reported under the headings: program coordination; analysis and data evaluation for Fuel Failure Mockup (FFM) bundles SC, SB, and SA; water system mockup of the FFM; development of coolant channel blockage detection methods; FFM facility operations; and LMFBR electric heater and LWR fuel pin simulator development. (DCC)

**21781** (ORNL-TM-4776) LMFBR SAFETY AND CORE SYSTEMS PROGRAMS PROGRESS REPORT FOR JULY–SEPTEMBER 1974. Fontana, M. H. (Oak Ridge National Lab., Tenn. (USA)). Jan 1975. Contract W-7405-eng-26. 61p. AT.

Progress is reported under the following headings: program coordination; analysis and data evaluation for unblocked Fuel Failure Mockup (FFM) bundles 2A and 5C; water system mockup of the FFM; testing of equipment to acoustically detect sodium boiling; FFM facility operations; and LMFBR electric heater and LWR fuel pin simulator development. (DCC)

**21782** (ORNL-TM-4798) QUARTERLY PROGRESS REPORT ON HTGR SAFETY STUDIES FOR THE DIVISION OF REACTOR SAFETY. Research for July–September 1974. Sanders, J. P. Sr. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 13p. Dep. NTIS $4.00.

Research during the quarter included core thermal analysis and code development and steam generator model development. (JWR)

**21783** (ORNL-tr-2908) DETECTION OF BLOCKAGES OF COOLING CHANNELS IN SODIUM-COOLED BREEDER REACTORS BY MEASUREMENT OF TEMPERATURE FLUCTUATIONS AT FUEL-ELEMENT OUTLET. Krebs, L.; Weinkoetz, G. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Reaktorbauelemente). [nd]. Translated by R. G. Mansfield, Oak Ridge National Lab., TN, from IRB-Memo-202/73. 21p. Dep. NTIS $4.25.

A technique for the determination of cooling channel blockages in LMFBR type reactors by making full use of information from temperature and flow sensors located at subassembly outlets is discussed. A heuristic description of the origin and propagation of temperature fluctuations in a fuel subassembly is presented. Some sample measurements in an out-of-pile sodium loop and in the KNK reactor are described. (JWR)

**21784** (ORO-4313-9-10) MOLTEN MATERIAL-COOLANT INTERACTION AND PLUTONIUM SOURCE IN LMFBR ACCIDENT ANALYSIS. Ninth and Tenth Quarterly Reports, December 15, 1973–June 30, 1974. (Virginia Univ., Charlottesville (USA)). Sep 1974. Contract AT(40-1)-4313. 122p. (NE-3949-109-74; NE-3949-110-74). Dep. NTIS $9.50.

Methods for calculating bounding values for the generation of fuel vapor during disassembly and during expansion of the fuel after disassembly in a fast-reactor core-disruptive accident are presented. Isentropic expansion of the fuel following disassembly is assumed. The method is applied to an LMFBR disassembly, first with sodium in the core and then with sodium removed. Consistent thermodynamic fuel properties used for the calculations are also presented. (auth)

**21785** (RD/B/N-3007) ROLE OF SPONTANEOUS NUCLEATION IN THERMAL EXPLOSIONS: FREON/WATER EXPERIMENTS. Board, S. J.; Hall, R. W.; Brown, G. E. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1974. 6p. Dep. NTIS (US Sales Only) $4.00.

Small-scale vapor explosions of Freon-22 in water were studied to determine the possibility of similar reactions between $UO_2$ and sodium in a fast reactor. The results show that efficient fragmentation explosions can occur even when the bulk liquid contact temperature is below the homogeneous nucleation point. (JWR)

**21786** (UJV-3255-R) NONLINEAR MODEL FOR THE DYNAMICS OF FUEL ELEMENT OF PRESSURIZED WATER REACTOR. Pernica, R. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). Jul 1974. 49p. (In Czech). Dep. NTIS (US Sales Only) $5.50.

A nonlinear dynamic model is described for transient analysis of the fuel element of pressurized water reactor. Fundamental parts of the model are formed by the thermohydraulics of two phase flow, the point kinetic model for a description of neutron kinetics and the fuel model. Basic equations, boundary conditions, method of solution and development of suitable numerical treatment are given. The description permits the determination of the vapor content and temperature field of coolant and fuel during transient processes. 20 references. (auth)

**21787** (WANL-TME-437(Rev.2)(Sect.7)) REACTOR ASSEMBLY LABORATORY CRITICALITY HAZARDS CONTROL PROCEDURES. Schaedel, C. T. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 29 Apr 1965. 31p. Dep. NTIS $4.75.

To maintain adequate criticality control during the assembly operations in the Reactor Assembly Laboratory at WANL, criticality control procedures have been established. These procedures insure safety from accidental criticality by either limiting mass, establishing the geometry, or restricting the handling of enriched uranium within and between designated work areas and their internal criticality zones, or through the use of nuclear poison material. (auth)

**21788** (WASH-1235) SITE POPULATION FACTOR: A TECHNIQUE FOR CONSIDERATION OF POPULATION IN SITE COMPARISON. Final Report. Kohler, J. E.; Kenneke, A. P.; Grimes, B. K. (USAEC Directorate of Licensing, Washington, D. C.). Oct 1974. 113p. Dep. NTIS $8.75.

A technique is described which can be used to assess the impact of population distributions around potential nuclear power plant sites. The technique, called the Site Population Factor (SPF), is based on a function that decreases with increasing distance from the reactor site. The SPF technique has been used to construct various maps of the United States depicting areas of low and high impact population distributions. The amount of land area which would be excluded if a particular SPF number were adopted as an initial screening criterion for various areas of the country has been tabulated. All maps were constructed using 1970 census data. The SPF technique presents a means of evaluating alternative sites from the standpoint of population distributions. (auth)

**21789** (XN-74-27(Rev.2)) BULGEX: A COMPUTER CODE TO DETERMINE THE DEFORMATION AND THE ONSET OF BULGING OF ZIRCALOY FUEL ROD CLADDING (APPLICABLE FOR LOSS OF COOLANT ACCIDENT CONDITIONS). Merckx, K. R. (Exxon Nuclear Co., Richland, Wash. (USA)). 31 Dec 1974. 102p.

During the hypothetical design base loss-of-coolant accident (LOCA), the coolant depressurization and reduced cooling capability causes an excess internal pressure differential in a fuel rod and high cladding temperatures. Under the assumed accident conditions, these conditions must be evaluated for cladding deformation and potential clad bulging to comply with the AEC Final Emergency Core Cooling Systems Criteria. A deformational model for zircaloy-cladding under the temperature, stress, and environmental conditions encountered during a LOCA has been incorporated in a time incremental code, BULGEX, which determines the deformation history, internal pressure history, and the onset of clad bulging. The theoretical bases for the BULGEX code, methods for interpreting these data, the resultant plastic and creep deformation model and stability criterion, and the results of sensitivity studies on typical BWR geometries are presented. 12 references. (auth)

**21790** (XN-74-27(Rev.2)(Suppl1)) BULGEX: A COMPUTER CODE TO DETERMINE THE DEFORMATION AND THE ONSET OF BULGING OF ZIRCALOY FUEL ROD CLADDING (APPLICABLE FOR LOSS OF COOLANT ACCIDENT CONDITIONS). Merckx, K. R. (Exxon Nuclear Co., Richland, Wash. (USA)). 10 Jan 1975. 32p.

Changes made to convert BULGEX/NOV74B to BULGXT/DEC74A, a sample input and output, and sensitivity studies for typical PWR fuel rod design parameters are presented. (auth)

**21791** (XN-74-27(Rev.2)(Suppl.2)) BULGEX: AN XTHETA SUBROUTINE TO CALCULATE MECHANICAL CLADDING RESPONSE DURING A PWR LOSS-OF-COOLANT ACCIDENT. Bjornard, T. A.; Merckx, K. R. (Exxon Nuclear Co., Richland, Wash. (USA)). 1 Jan 1975. 23p.

The calculation sequences of BULGEX are described for using XTHETA as a FORTRAN V subroutine. This subroutine performs the same plastic and creep deformation calculations as the other code versions of BULGEX and has the advantage of performing the calculations concurrent with the rod heatup calculation. Thus, cladding deformation feedback is provided to XTHETA at each time step. By accounting for the cladding deformation effects on the pellet to clad gap size, gap heat transfer coefficients and cladding surface areas—both inside and outside the rod—the XTHETA-BULGEX code system is in this respect consistent with the LOCA analysis requirements of 10CFR50, Appendix K. Fuel swelling, densification, and cracking are taken into account in the input. 7 references. (auth)

**21792** (XN-75-7) RESPONSE TO REQUEST ADDITIONAL INFORMATION FROM USAEC (NRC), DECEMBER 4, 1974. Merckx, K. R. (Exxon Nuclear Co., Richland, Wash. (USA)). 10 Jan 1975. 17p.

Requested information is presented concerning the BULGEX code for analyzing the response of zircaloy cladding to loss-of-coolant accident conditions. (DCC)

**21793** RELIABILITY ANALYSIS TO OBJECTIVATE THE EVALUATION OF TECHNICAL SYSTEMS. Basti, W. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Atomwirt., Atomtech.; 19: No. 10, 474-477(Oct 1974). (In German).

2 figs.

Reliability analysis has proved to be very successful in various modern technologies, such as radar and space flight. These successes were achieved under the premise that the reliability analyses were done at a time when failures occuring due to systematic errors were practically eliminated. Now reliability analysis is more and more used in reactor technology for the evaluation of safety and availability. The technical conditions and limited experience with respect to the performance of components, absence of accident statistics, as well as a certain psychological handicap due to a deterministic way of thinking characteristic of engineers make reliability analysis an important method for the evaluation of the safety of nuclear power plants. (HDR)

**21794** CRITERIA FOR THE SITING OF NUCLEAR POWER STATIONS. Boeck, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 312-315(Jun 1974). (In German).

The choice of suitable sites for nuclear power stations in industrial nations with high population density is particularly difficult because consideration must be given to a large number of very diverse factors. These factors are discussed and the criteria used for siting nuclear power stations in the USA, the United Kingdom and the German Federal Republic are given. The possibility of building nuclear power stations underground or on islands in coastal waters is examined. (INIS)

**21795** EMISSION OF RADIOACTIVE GASES FROM NUCLEAR POWER STATIONS. Fleck, C. M. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 356-358(Jun 1974). (In German).

The release of halogens and rare-gas fission products from the reactor core and the cooling circuits of boiling water and pressurized-water reactors is considered. As a specific example the release of I-131 on a boiling-water reactor with a thermal rating of 2100 MW is calculated and compared with the specified value. (INIS)

**21796** DISCUSSION OF REACTOR FAULTS WHICH HAVE OCCURRED AND THEIR CONSEQUENCES. Boeck, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 364-368(Jun 1974). (In German).

The incidents and accidents to personnel which have occurred in nuclear installations since 1945 are briefly analyzed and the accidents which have taken place on the Lucens, Obrigheim and Würgassen reactors are analyzed more closely. The distribution of faults in power reactors is discussed and it is concluded that the highest incidence of faults is in the conventional equipment of reactors. (INIS)

**21797** SHIELDS TO PREVENT THE ESCAPE OF RADIOACTIVITY. Fleck, C. M. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 320-324(Jun 1974). (In German).

The safety concepts of the most serious admissible accident to a nuclear reactor and the use of Farmer's model are discussed and the most important requirements which have to be met for reactor safety are derived. The reliability of reactor pressure vessels and redundant protective systems are discussed as particular examples. (INIS)

**21798** SAFETY TESTS AND RADIATION PROTECTION IN NUCLEAR POWER STATIONS. Tschirf, E. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 316-319(Jun 1974). (In German).

Safety tests, running check measurements on the environment and radiological supervision of operating personnel are some of the more important functions of the radiation protection department of a nuclear power station. A brief description of present practice is given and the methods used to solve different problems which arise during the operation of nuclear power stations are discussed and examples are given. (INIS)

**21799** RADIOLOGICAL SAFETY GUIDES FOR POPULATION IN POLAND: THE PRINCIPLES FOR SETTING, AND APPLICATION BY DESIGNERS OF NUCLEAR INSTALLATIONS. Pensko, J. (Inst. for Nuclear Research, Swierk, Poland). pp 155-165 of Population Dose Evaluation and Standards for Man and his Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF 740529-.

The bases for setting the radiological safety guides for the population in Poland are discussed. The discussion covers the individual and collective dose limits for the population in normal operation of nuclear installations as well as emergency guides for accidental situations. The principles of the application of these guides by designers of nuclear installations in this country are also defined. (auth)

**21800** ATMOSPHERIC STABILITY INSIDE CONTAINMENTS WITH A HEATED LAYER OF LIQUID ON THE FLOOR. van de Vate, J.; Plomp, A. (Reactor Centrum Nederland, Petten). Nucl. Sci. Eng.; 56: No. 2, 196-200(Feb 1975).

A simple boundary condition has been derived which allows prediction of the stability of an enclosed atmosphere above a heated liquid. The correctness of the condition has been shown by experiments with various vapor-gas systems. Application to nuclear reactor containments under hypothetical accident conditions demonstrates the presence of a stirred atmosphere for sodium-cooled reactors. In case of water-cooled reactors, the containment atmosphere will be stirred when large amounts of fission products are present in the sump water in the concrete cavities located in the lower part of the containment building. (auth)

**21801** COMPUTATIONAL MODELS FOR THE STUDY OF AZIMUTHALLY DEPENDENT DISASSEMBLY OF LIQUID-METAL FAST BREEDER REACTORS. Bleiweis, P. B. (Univ. of Illinois, Urbana); Kastenberg, W. E.; Okrent, D. Nucl. Sci. Eng.; 56: No. 2, 152-170(Feb 1975).

Two angular-dependent liquid-metal fast breeder reactor (LMFBR) disassembly models are derived. These models are based on the physical assumptions of the VENUS (r, z) computer codes (VENUS and VENUS-II). A two-dimensional (r, $\theta$) model is derived to study disassembly in an infinitely long cylinder. The second model is an approximate three-dimensional model which employs the Galerkin method (a subset of the method of weighted residuals) to solve for the three-dimensional motions of materials during disassembly. An iterative technique which is employed to calculate trial and weighting functions for the Galerkin method is proposed and tested. The two angular-dependent disassembly models are used to study four configurations of a reference 1000-MW(e) LMFBR. Most of the calculations performed employ the two-dimensional (r, $\theta$) model to estimate the effects of angular dependence on three-dimensional calculations. In addition, a number of three-dimensional calculations are presented both to validate the model and to study the relative effect of angular motion on LMFBR disassemblies. The results indicate that angular motion is second order compared to radial and axial motions for the four configurations studied. These calculations also indicate that the models derived are relatively simple and

inexpensive to use and can be employed to study other configurations which may be more dependent on angular motion during a disassembly accident than the four chosen for this study. (auth)

**21802** GENERAL CONSIDERATIONS ON THE DESIGN OF PROTECTION SYSTEMS FOR NUCLEAR REACTORS. Blaess, B. (Siemens A. G., Karlsruhe (F. R. Germany). Systemtechnische Entwicklung). Kerntechnik; 16: No. 10, 421-428 (Oct 1974). (In German, English).

Starting from the general task of a protection system, the requirements and criteria important for the development, design and construction of protection systems are discussed. A comprehensive review is presented of the most important considerations, in the light of the current status of engineering development. Some of the terms used are explained. (auth)

## Reactor Theory and Calculation

*Refer also to abstracts 21146, 21477, and 21851.*

**21803** (CONF-741065-1) PROBABILITY PROFILES AND MOMENTS OF NEUTRON COUNT DISTRIBUTION VIA THE KOLMOGOROV EQUATIONS. Arcipiani, B.; Marseguerra, M. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Lab. Fisica e Calcolo dei Reattori; Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). 1974. 22p. Dep. NTIS (US Sales Only) $4.25.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

The distribution of neutron counts in a subcritical multiplying system with an external source has been investigated in the framework of the Kolmogorov equations (KE), introducing some generalizations. The backward KE, without delayed neutrons, has been solved for the probability generating function (pgf) in the case of many counting intervals and suitably differentiated for the determination of joint probabilities and moments. (auth)

**21804** (CONF-741065-5) REACTOR GAMMA NOISE STUDIES. Baers, B. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorilaboratorio). 1974. 18p. Dep. NTIS (US Sales Only) $4.00.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

A brief review is given of reactor gamma noise studies, with emphasis on experience gained from subcritical reactors at Otaniemi, Finland, along with a survey of the development of stochastic models, numerical studies and gamma noise measurements. (auth)

**21805** (CONF-741065-36) BOILING ANOMALY DETECTION BY ACOUSTIC NOISE MEASUREMENT. Nishihara, H. (Kyoto Univ. (Japan). Faculty of Engineering). 1974. 7p. Dep. NTIS (US Sales Only) $4.00.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

Some fundamental aspects of boiling noise are reported based on experimental results obtained with water. Acoustic noise generated by nucleate pool boiling of water produced by heating electrically a thin platinum wire at atmospheric pressure from the incipience of boiling to the burnout of the heater was investigated experimentally. (auth)

**21806** (CONF-741065-37) STOCHASTIC KINETICS: ANALYTICAL SOLUTIONS OF DETAILED PROBABILITY BALANCE EQUATIONS. Norelli, F.; Jorio, V. M.; Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Lab. Fisica e Calcolo dei Reattori). 1974. 21p. Dep. NTIS (US Sales Only) $4.25.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

A formulation of nuclear reactor kinetics according to a stochastic approach is proposed. A balance equation is written for the probability of finding the nuclear system in a certain state at a given instant of time. The Chapman–Kolmogorov equations are derived for a reactor. The state is characterized by the neutron population, the delayed neutron precursor population, and the number of detected neutrons. Equations are treated and integrated in search of a probability profile. A number of cases are analyzed via a progressive criterion: starting with a very simple model and gradually taking into account an increasing number of physical processes within the chosen system. (auth)

**21807** (CONF-741065-38) TWO-PARTICLE CORRELATIONS IN REACTOR SYSTEMS. Mika, J. (Institute of Nuclear Research, Warsaw (Poland)). 1974. 25p. Dep. NTIS (US Sales Only) $4.25.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

For most practical purposes a comprehensive description of a given reactor system is supplied by the neutron equation supplemented by the equations for delayed neutron precursors. Such a system of equations, which may be referred to as the generalized transport equation, was thoroughly investigated in a Hilbert space of square integrable functions, and the existence of its unique solution was proved, thus supplying a firm basis for investigating various approximate methods for numerical reactor calculations. (auth)

**21808** (CONF-741065-40) INVESTIGATIONS OF THE INFLUENCE OF FEEDBACK AND COUPLING EFFECTS ON NEUTRON NOISE IN A NUCLEAR REACTOR. Vaeth, W. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). 1974. 31p. Dep. NTIS (US Sales Only) $4.75.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

A description is given of investigations into the influence of a control loop with known transfer function on the spectra of neutron chamber signals. Theoretical formulas for the spectra are derived using the point reactor model. These formulas were verified by noise measurements in a zero power reactor. In addition, special attention is given to the noise generated by the control loop. The influence of this feedback noise on the spectra is verified experimentally. In large reactors space dependent transfer functions must be taken into account. As a first approximation to handle the spatial dependence, the investigations were extended to the two-point reactor model. Corresponding experimental work was done for the Argonaut Reactor Karlsruhe (ARK) with a symmetrical two-slab core loading. As an application to a more realistic situation, coolant boiling in a BWR has been investigated. The boiling must be considered as a feedback mechanism as well as an external reactivity perturbation. In order to simulate the steam bubble content, nitrogen gas was injected into the water moderator of the ARK. By modulating the total gas flow according to the instantaneous reactor power, the feedback effect was simulated. The gas flow produced a bandlimited, white reactivity noise. The upper break frequency could be used to determine the travelling time of the bubbles through the core. (auth)

**21809** (CONF-741065-41) THEORY OF CORRELATION MEASUREMENT IN TIME AND FREQUENCY DOMAINS WITH $^{252}$Cf. Mihalczo, J. T.; Pare, V. K. (Oak Ridge National Lab., Tenn. (USA)). 1974. 27p. Dep. NTIS $4.50.

From EACRP specialist meeting on reactor noise from critical assemblies to power plants; Rome, Italy (21 Oct 1974).

The theory of cross-correlation measurements between the pulses from an ionization counter containing a $^{252}$Cf neutron source, which furnished the initiators of fission chains in a neutron-multiplying assembly, and the pulses from a detector observing the particles from the fission chains is reviewed. The expression for the detector response in this type of measurement is first presented in the time domain. Then the cross-power spectral densities in the frequency domain measurements are developed. The theory of the usual two-detector noise measurement is reformulated to incorporate a modified Diven factor that includes the effects of neutrons from external sources such as spontaneous fission of the californium and the reactor fuel. Finally, the equivalence between both the time and frequency domain expressions is demonstrated. A new method of reactivity determination is proposed which avoids some of the difficulties of the present methods, such as dependence on detection efficiency and inherent source strength, and the requirement for a calibration near delayed criticality. (auth)

**21810** (GA-A-13077) FRNTIC: A COMPUTER CODE FOR WEIGHTED LEAST SQUARES ANALYSIS FOR PULSED-NEUTRON DATA. Pfeiffer, W. (General Atomic Co., San Diego, Calif. (USA)). Jul 1974. Contract AT(04-3)-633. 110p. Dep. NTIS $5.45.

A computer code for analyzing the detector count data from a pulsed-neutron experiment by performing a weighted least squares fit is presented. The raw count data are first corrected for any dead time losses due to high count rates, and the appropriate statistical weights are computed. A count model consisting of a sum of exponentials is fit to the dead-time-corrected counts using weighted least squares. If desired, the model may include either a constant background or a time-dependent background due to delayed neutrons. The parameters, i.e., the amplitudes and decay constants of the exponential components, may be either variable or fixed. If variable, then they are determined by minimizing the weighted sum of the squares of the residuals. (The residuals are the differences between the measured and modeled counts.) Because the assumed model is nonlinear in the parameters, the normal equations, which result from minimizing the sum of the squares, are also nonlinear. However, by repeated linearization of the model, the normal equations can be solved

iteratively to obtain the most probable values for the parameters. Confidence intervals for the parameters are also calculated, as is the variance of fit, which provides a measure of the goodness of fit. (auth)

**21811** (IKE-4-25) FEM2D--A PROGRAM FOR SOLVING THE TWO-DIMENSIONAL DIFFUSION EQUATION ON THE BASIS OF THE FINITE ELEMENT METHOD. Franke, H. P.; Schmidt, F. A. R. (Stuttgart Univ. (TH) (F. R. Germany). Inst. fuer Kernenergetik). Jul 1975. vp. (In German). INIS.

12 figs.; 21 tabs.; 17 refs. Available from ZAED.

The program FEM2D is based on the Finite Element Method. The application of this method to two-dimensional diffusion problems is discussed. The realisation of FEM in FEM2D is explained. The report is completed by descriptions of the program structure, the input data, the output data, and two sample calculations for realistic light-water reactor problems. (auth)

**21812** (INIS-mf-1383, pp 5-12) ITERATION SYNTHESIS PROCEDURE FOR NEUTRON TRANSPORT EQUATION SOLUTION. Khromov, V. V. 1973. (In Russian).

An algorithm for the solution of the neutron transport equation by iteration synthesis was reported. The results of the numerical calculation for a neutron flux in a reactor having a cross-shaped active zone, made for the purpose of confirming the algorithm proposed, were given. The results showed the stability of the method and the good convergence of the iteration process. (Tr-INIS)

**21813** (WANL-TME-1498) STATUS REPORT ON THE B1T PROGRAM PROVIDES THERMAL-NEUTRON FLUX AND CURRENT SPECTRA, ISOTROPIC AND ANISOTROPIC GROUP CROSS SECTIONS. Gibson, G.; Collier, G. (Aerojet-General Corp., Sacramento, Calif. (USA)). Aug 1966. 43p. Dep. NTIS $5.25.

Methods of calculating neutron fluxes and energy spectra in NERVA reactor type environments are discussed, with emphasis on the method (iterative), binding effects, anisotropy, scattering, cross sections, transport, etc. (LTN)

**21814** SYNTHETIC KERNEL FOR ANISOTROPIC SCATTERING AND ITS APPLICATION TO CALCULATIONS OF FAST NEUTRON SPECTRUM AND SPATIAL MOMENTS. Yamamura, Y.; Yamamoto, K.; Sekiya, T. (Osaka Univ., Suita (Japan). Dept. of Nuclear Engineering). Atomkernenergie; 24: No. 1, 1-8(1974).

6 figs.; 5 tabs.; 15 refs.

A direct numerical method for the calculation of the fast neutron spectrum and other reactor parameters has been investigated: synthetic kernel approximation for the numerical solution of the Boltzmann-equation by means of a recurrence formula. Two series of separate-type synthetic kernels are proposed: the generalized Greuling-Goertzel kernels $G_n^1(u' \rightarrow u)$ and the generalized Wigner kernels $W_n^1(u' \rightarrow u)$, estimating explicitly the effect of the angular distribution in the center-of-mass system upon the anisotropic scattering in the laboratory system. The approximation permits the quick and precise calculation of neutron spectra and other reactor parameters. The neutron spectra calculated with the higher-order kernels $G_7^0(u' \rightarrow u)$ and $W_7^1(u' \rightarrow u)$ can be regarded as "exact" ones. This holds for any composition of resonant materials with narrow as well as wide resonances. (GE)

**21815** ON THE TIME-DEPENDENT GREEN'S FUNCTION FOR MONOENERGETIC NEUTRON TRANSPORT. Ganapol, B. D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Etudes des Reacteurs et de Mathematiques Appliquees). Atomkernenergie; 24: No. 1, 70-72 (1974).

2 refs.

C. Syros presented a derivation of the time-dependent Green's function for monoenergetic neutron transport in plant geometry by applying the Laplace and Fourier transforms to multiple collision equations. It seems however, that his solution does not correctly take into account the behavior of the transformed flux in the complex plane. The purpose of this communication is to present a corrected solution and to use this solution to derive a closed form for the total flux distribution. (auth)

**21816** ANALYTICAL SOLUTION OF THE POSITION-DEPENDENT PLANAR NEUTRON TRANSPORT PROBLEM, TAKING INTO ACCOUNT ANISOTROPIC SCATTERING AND SEVERAL ENERGY GROUPS. Lepori, C.; Auerbach, H. T.; Haelg, W.; Mennig, J. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). Z. Angew. Math. Phys.; 25: No. 1, 132-135(25 Jan 1974). (In German).

From Swiss Physical Society Autumn Meeting; Lugano, Switzerland (19 Oct 1973).

Starting from the time-independent Boltzmann equation for the case of a non-multiplying medium, and planar one-dimensional geometry, boundary conditions are stated for a screening problem, and some acceptable simplifications discussed. A solution of the equation system as in Code ANISN of Oak Ridge, requires many support points, hence is wasteful in calculating time and store capacity. An analytical method of solution with exponential start is touched upon; a further method based on a power series development (Lie series) is dealt with in some detail. (INIS)

**21817** A MODIFIED $P_1$-APPROXIMATION FOR THE MULTIDIMENSIONAL NEUTRON TRANSPORT EQUATION. Sigg, B.; Mennig, J. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). Z. Angew. Math. Phys.; 25: No. 1, 139-141(25 Jan 1974). (In German).

From Swiss Physical Society Autumn Meeting; Lugano, Switzerland (19 Oct 1973).

The $P_1$-approximation of the mono-energetic, stationary Boltzmann equation is given in rotational-symmetrical cylinder geometry. An expression for the direction-dependent neutron flux is also given. Six shortcomings of the $P_1$-equations are set out in some detail and, step by step, additional conditions are formulated to overcome them. (INIS)

**21818** THE USE OF WALSH FUNCTIONS IN THE SOLUTION OF NEUTRON TRANSPORT PROBLEMS. Haelg, W.; Auberbach, H. T.; Gassmann, J.; Mennig, J. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). Z. Angew. Math. Phys.; 25: No. 1, 135-138(25 Jan 1974). (In German).

From Swiss Physical Society Autumn Meeting; Lugano, Switzerland (29 Oct 1973).

It is pointed out that the design of nuclear reactors leads in general to the need to solve an integro-differential equation for the neutron density function for prescribed initial and boundary conditions and that the variables of these Boltzmann's transport equations are, besides time, the space coordinates, the energy of the neutrons and the direction of their velocity vectors. Recent literature suggests the use of an orthogonal system which can take only discrete function values −1 and +1. An investigation is made to ascertain if, as a consequence of this, a system of this nature could be used to solve the Boltzmann equation, and permit the use of a digital computer in the calculations. It is established that the Walsh development is not, however, justified except in special circumstances. (INIS)

**21819** HIGHER ORDER RELATIONSHIP BETWEEN STATIC POWER TILTS AND EIGENVALUE SEPARATION IN NUCLEAR REACTORS. Beckner, W. D.; Rydin, R. A. (Univ. of Virginia, Charlottesville). Nucl. Sci. Eng.; 56: No. 2, 131-141(Feb 1975).

The lambda-mode eigenvalue separation can potentially be evaluated in a power reactor using a static flux tilt method. The flux tilt, or offset, is measured per unit of perturbing reactivity, which is then related theoretically to the desired parameter. The use of higher order theory has explained a discrepancy in previous experimental correlations and has led to a procedure for more accurately estimating the parameter from the data. (auth)

**21820** CHARACTERISTICS OF UNCERTAINTIES IN SENSITIVITY STUDIES FOR FAST-REACTOR PARAMETERS. Hwang, R. N. (Argonne National Lab. IL). Nucl. Sci. Eng.; 56: No. 2, 119-130(Feb 1975).

Some general characteristics are described of the uncertainties in various fast-reactor parameters as a function of the corresponding uncertainties in nuclear data on the basis of statistical theory. By using the variational formalism, it is possible to relate the mean-square deviation of any reactivity coefficient (or reaction-rate ratio) to the covariance matrix of cross sections. The qualitative behavior of the uncertainties in fast-reactor parameters can be best illustrated geometrically in terms of the region of tolerance. The latter is the volume bound by a "hyperellipsoid" surface specified by the designer's tolerance limit, the coefficients characteristic of the type of parameter in the system under consideration, and the correlation matrix. Exploratory studies and graphical illustrations are given for some cases of practical interest. (auth)

**21821** NON-STATIONARY STATES OF FAST REACTORS: AIMS AND POSSIBILITIES OF COMPUTATION. Otcenasek, P. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 47-52(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The choice is analyzed of a mathematical model considering the particularities of the computed transition process. The analysis is based on equations describing, by means of various approximations, non-stationary states of neutron economy. The necessity is shown of elaborating a number of specific programmes related to the individual types of non-stationary states. They may be based on a multigroup transport model. (INIS)

**21822** SIMULATION OF NEUTRON FIELDS. Simane, C. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 107-112(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

Methods are discussed of simulating neutron fields. It was found that the best results could be achieved in an annular core reactor. Comparable results were achieved using a cylindrical model of the core, rotating in a horizontal neutron beam. (INIS)

**21823** PRACTICAL PREPROCESSED NUCLEAR DATA FILES FOR FAST REACTOR CALCULATIONS. Gur, Y.; Yiftah, S. (Israel Atomic Energy Commission, Yavne). Nucl. Sci. Eng.; 56: No. 2, 202-210(Feb 1975).

A new method is presented that enables the user to obtain from a preprocessed library, in a few computer seconds, effective self-shielded multigroup cross-section sets averaged over any desired weighting function without reference to the basic data library. Specifications of the preprocessed library (only 2 to 3 times as large as a Bondarenko-type library) are given. The preprocessed library may be generated using existing codes. A family of functions with terms into which any weighting function can be expanded is used. Group averages of each cross section with respect to terms of the family and a set of shielding factors form the preprocessed library. Two families of functions, $f_n(E)$, are considered, and two methods are given for the expansion of W(E) into each series of $f_n(E)$. Nuclear parameters obtained by these methods are compared with the same parameters obtained using the exact weighting function (SNEAK flux) to check the methods. Very good agreement is found. (auth)

# Reactor Components and Accessories

*Refer also to abstracts 20188, 20252, 20253, 20325, 20330, 20360, 20432, 20437, and 20482.*

**21824** (AED-CONF-74-496-002) DESIGN OF BUILDINGS TO PROTECT THEM FROM EXTERNAL IMPACTS AND CONSEQUENCES FOR INDIVIDUAL COMPONENTS. Jonas, W. (Hochtief A.G., Frankfurt am Main (F.R. Germany)). 1974. 16p. (In German). (CONF-741075-4). INIS.

From meeting on protection of nuclear power plants from external impacts; Koeln, F.R. Germany (30 Oct 1974).

With abstract in German and English.

Practical ways in analysing external impacts on buildings as seen by a civil engineer are described. The various problems with their main characteristics are discussed, including sketches of their numerical handling. A few examples are chosen for illustration purposes. Open problems and their relevance in the construction of nuclear power stations are pointed out. (auth)

**21825** (AED-CONF-74-496-003) OPTIMIZATION OF PROTECTION FROM EXTERNAL IMPACTS AS A FACTOR INFLUENCING THE CONCEPTUAL DESIGN IN THE PLANNING OF NUCLEAR PLANTS. Jungclaus, D. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e. V., Koeln (F. R. Germany)). 1974. 24p. (In German). (CONF-741075-1). INIS.

From meeting on protection of nuclear power plants from external impacts; Koeln, F. R. Germany (30 Oct 1974).

With abstract in German and English.

Points of view will be presented which determine the building arrangement of nuclear power plants. In addition, principles will be established for protection from external impacts. The application of those principles will be illustrated by use of floor plants and model photographs of plants already built or undergoing the licensing procedure. A possible building will be discussed, based on the design of a pressurized water reactor with special reference to the external impacts. (auth)

**21826** (CEA-N-1735) EXPERIMENTAL STUDY OF TWO SINGULAR POINTS IN A CIRCUIT. Gibert, R. J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). Jul 1974. 210p. (In French). Dep. NTIS (US Sales Only) $13.50.

Thesis. Submitted to Paris Univ., France.

The singular points discussed consist of a sudden broadening (sudden passage from a cylindrical tube of diameter d to a cylindrical tube of diameter D) and a 7 deg diffuser (gradual passage from a tube of diameter d to another of diameter D). In a circuit the singular points set up both local fluctuations immediately downstream from the singular point and acoustical fluctuations locally generated and propagated by plane waves throughout the circuit. The two types of fluctuation are characterized independently of the rest of the circuit. An experimental analysis leads to the establishment of simple laws from which can be determined, for any d/D ratio and any flow rate, the interspectral properties of the local fluctuations and the spectral properties of the acoustical source associated with the singular point. A theory of noise generation by perturbed flow in internal acoustics is developed which can be used to calculate the acoustical properties of a singular point from the local characteristics. (FR)

**21827** (CONF-7210130-) PROCEEDINGS OF THE COLLOQUIUM ON STRUCTURAL RELIABILITY: THE IMPACT OF ADVANCED MATERIALS ON ENGINEERING DESIGN, WRIGHT PATTERSON AFB, OHIO, 9-12 OCTOBER 1972. Swedlow, J. L.; Cruse, T. A.; Halpin, J. C. (eds.). (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Mechanical Engineering). 1972. 597p.

An abstract is included for one of the 28 papers presented concerning stress analysis and reliability of mechanical structures. (DCC)

*For an abstract of an individual paper see: 21369.*

**21828** (CONF-741109-5) RECENT TRENDS IN REACTOR SHIELDING IN THE USA. Trubey, D. K. (Oak Ridge National Lab., Tenn. (USA)). 1974. 10p. Dep. NTIS $4.00.

From international symposium on radiation physics; Calcutta, India (30 Nov 1974).

Reactor shielding research and development activities in LMFBR, LWR, and HTGR programs are discussed. Improvements in shielding design capabilities are attributed to: (1) the increased use of discrete ordinate and Monte Carlo methods instead of empirical methods and approximations, (2) improvements in cross section availability and application, (3) USAEC financial support of LMFBR and fusion reactor shielding research and development, (4) greater sophistication in the nuclear power industry, and (5) stronger nuclear industry emphasis on standards. (DG)

**21829** (KFK-1984) INVESTIGATIONS CONCERNING THE MODELING OF COOLING TOWER PLUMES IN SMALL-SCALE EXPERIMENTS. Werle, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (F. R. Germany). Projekt Nukleare Sicherheit). Aug 1974. 55p. (In German). INIS.

12 figs.; 5 tabs.; 10 refs.

A model theory is applied to cooling tower plumes. It turns out that a large part of the conditions representative of real cooling towers can be modeled in a small low-speed wind tunnel. Measurements of the space distribution of velocity, temperature and moisture would give information concerning the influence of condensation and evaporation on the temperature and velocity field, the exchange coefficients characteristic of the self-turbulence of the plume, and deliver integral data (length of the fog plume, asymptotic height) to check the results of calculations. (auth)

**21830** (KFK-2031) CONTRIBUTION TO DETERMINE COST OPTIMAL LIFE TESTS FOR COMPONENTS WITH EXPONENTIALLY DISTRIBUTED LIFETIMES. Sellinschegg, D. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik; Karlsruhe Univ. (TH) (F. R. Germany). Fakultaet fuer Wirtschaftswissenschaften). Jul 1974. 56p. (In German). INIS.

20 refs.

The determination of cost optimal plans for life tests is presented. For drawing statistical inference on the basis of the gathered data, the method of testing hypotheses, interval estimates and the determination of estimators is used. The aim of this work is to determine a plan in such a way that for an optimal statistical decision procedure the expected experimental cost is as low as possible for a given degree of efficiency for the statistical inference. The investigation is done with a cost model, which considers the investment and operating costs of the test facility, the cost for the component to be tested and the cost (penalty or bonus) for meeting the specified contract length. (auth)

**21831** (N-74-14586) NASTRAN: USERS' EXPERIENCES. Third Colloquium, Langley Research Center, Hampton, Virginia, September 11-12, 1973. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). Sep 1973. 740p. (CONF-730959-; NASA-TM-X-2893). NTIS $14.75.

The proceedings of a conference on NASA Structural Analysis (NASTRAN) to analyze the experiences of users of the program are presented. The subjects discussed include the following: (1) statics and buckling, (2) vibrations and dynamics, (3) substructing, (4) new capability, (5) user's experience and (6) system experience. Specific applications of NASTRAN to spacecraft, aircraft,

nuclear power plants, and materials tests are reported. Separate abstracts are included for 2 of the 38 papers presented. (auth)

*For abstracts of individual papers see: 21832 and 21833.*

**21832** (N-74-14586, pp 243-249) SEISMIC ANALYSIS OF NUCLEAR POWER PLANT STRUCTURES. Go, J. C. D. (Computer Sciences Corp., Las Vegas, NV). Sep 1973.

From third NASTRAN colloquium; Hampton, Virginia, USA (11 Sep 1973).

In NASTRAN: users' experiences.

Primary structures for nuclear power plants are designed to resist expected earthquakes of the site. Two intensities are referred to as Operating Basis Earthquake and Design Basis Earthquake. These structures are required to accommodate these seismic loadings without loss of their functional integrity. Thus, no plastic yield is allowed. The application of NASTRAN in analyzing some of these seismic induced structural dynamic problems is described. A brief review of the formulation of seismic-induced structural dynamics is also presented. Two typical structural problems were selected to illustrate the application of the various methods of seismic structural analysis by the NASTRAN system. (auth)

**21833** (N-74-14586, pp 585-594) USE OF NASTRAN FOR NUCLEAR POWER PLANT STRUCTURAL ANALYSIS AND DESIGN. Setlur, A. V.; Valathur, M. (Pioneer Service and Engineering Co., Chicago). Sep 1973.

From third NASTRAN colloquium; Hampton, Virginia, USA (11 Sep 1973).

In NASTRAN: users' experiences.

Some of the studies made on the use of NASTRAN for nuclear power plant analysis and design are presented. These studies indicate that NASTRAN could be effectively used for static, dynamic and special purpose problems encountered in the design of such plants. Normal mode capability of NASTRAN is extended through a post-processor program to handle seismic analysis. Static and dynamic substructuring is discussed. Extension of NASTRAN to include the needs in the civil engineering industry is discussed. (auth)

**21834** INSTRUMENTATION AND PROTECTION OF NUCLEAR POWER STATIONS. Weiss, H. (Technische Hochschule, Graz (Austria)). Elektrotech. Maschinenbau; 91: No. 6, 337-344 (Jun 1974). (In German).

Besides the control scheme, which, by measuring a number of conventional and nuclear parameters, permits satisfactory operation of a reactor, the protective schemes are of particular importance in nuclear power stations. With increasing unit ratings and the siting of power stations in highly populated areas even stricter attention is paid to protective and safety schemes by both certifying authorities and manufacturers. The requirements from protective schemes and the determination of reliability are discussed. Computerized protective schemes because of their greater flexibility and superior performance are likely to replace conventional schemes in the near future. (INIS)

**21835** LIQUID RADIOACTIVE WASTE PRODUCTS. Buchtela, K. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 352-355(Jun 1974). (In German).

The importance and significance of waste water treatment in a nuclear power station is discussed from the point of view of protection of the environment and in the interests of efficient operation of the station. The sources of liquid, radioactive waste materials are enumerated and the possibilities and techniques of treatment are briefly described. (INIS)

**21836** POWER SUPPLY TO AUXILIARIES IN NUCLEAR POWER STATIONS. Stimmer, H. (Technische Hochschule, Vienna (Austria)). Elektrotech. Maschinenbau; 91: No. 6, 344-348(Jun 1974). (In German).

Extremely high demands are made on the security of power supply to the auxiliaries in nuclear power stations. Designs with functional and physical redundancy in the power supply and distribution system ensure that even on the occurrence of major faults and disturbances the power supply is maintained to the most important auxiliaries. Comprehensive monitoring of the operation of the auxiliaries is of great importance. (INIS)

**21837** FRACTURE SAFETY OF NUCLEAR COMPONENTS. Varga, T. Neue Tech.; 16: No. 7, 284-290(Jul 1974). (In German).

After brief reference to the basic principles of stress analysis and dimensioning of parts, the significance of failure of metallic materials is discussed. It is shown how the safety of nuclear components can be enhanced by deeper knowledge of the mechanism of failure, more accurate calculations, greater care during manufacture and stricter inspection and testing. The requirements to avoid failure are briefly stated and brittle fracture, influence of load, creep, corrosion and fatigue are considered. The important role played by material testing is stressed and reference is made to some of the techniques used. (INIS)

**21838** STRESS ANALYSIS OF HIGH-PRESSURE PIPE SYSTEMS. Thies, J.; Jacobi, A. (Motor-Columbus Ingenieurunternehmung A. G., Baden (Switzerland)). Neue Tech.; 16: No. 7, 276-284(Jul 1974). (In German).

Purchasers of nuclear power stations in Western Europe have a tendency to specify that the design and testing of pipe systems for nuclear power stations comply with the ASME Codes. A brief account is given in the procedure, the factors and normal and abnormal operating conditions which have to be considered, the parameters involved and the design methods with a reference to existing computer programs to ensure that the pipe system complies with the ASME Codes. The theory of the methods of calculation is not given because it can be found in the relevant literature. (INIS)

**21839** THE END BLADES OF LARGE STEAM TURBINES. Hohn, A.; Novacek, P. (Brown, Boveri and Co. Ltd., Baden (Switzerland)). Neue Tech.; 16: No. 7, 269-275(Jul 1974). (In German).

The large increase in unit ratings of steam turbines and particularly the operating conditions in nuclear power stations impose heavy demands on the end blades because of the very high rates of steam flow so that greater attention is being paid to their design than formerly. Static and dynamic stress analysis of blades, the effect of material and angle of twist, improvements in blade profile, blade root fixing, vibration analysis and measurement, blade erosion and principal turbine dimensions are briefly considered. (INIS)

**21840** SAFETY CONSIDERATIONS IN THE DESIGN AND CONSTRUCTIONS OF NUCLEAR STEAM GENERATORS. Fritz, K. (Waagner-Biro A. G., Vienna (Austria)). Elektrotech. Maschinenbau; 91: No. 6, 328-337(Jun 1974). (In German).

The design of steam generators for nuclear power stations must take into account the nuclear safety aspects of the primary circuit as well as the requirements of the secondary circuit so as to improve as much as possible availability and safety. The constructional features of steam generators typically used for different types of reactor are described and the operating characteristics are discussed. A new design method based on statistical criteria is put forward. (INIS)

**21841** SPECIAL REQUIREMENTS OF THE INSTRUMENTATION IN NUCLEAR POWER STATIONS AND NUCLEAR PROCESSING PLANTS. Dahse, H. (Siemens A. G., Karlsruhe (F. R. Germany). Geschaeftsbereich Mess- und Prozesstechnik). Kerntechnik; 16: No. 10, 449-454(Oct 1974). (In English, German).

The requirements for apparatus, instruments, valves, measuring orifices etc. in nuclear power stations and nuclear processing plants are described. Main points are the materials, cleanliness, corrosion resistance and possibility of decontamination of the surface and their freedom from leakage. (auth)

**21842** METHOD FOR PUMPING LIQUID METALS BY DRIVING EFFECT AND A PUMP FOR CARRYING OUT SAID METHOD. Malaval, C. (to Groupement pour les Activites Atomiques et Avancees). French Patent 2,182,623/A/. 30 May 1972. 8p. (In French).

Description is given of a method for pumping liquid metals and of a pump for carrying out said method, providing a high output-rate under high pressure. Under the action of a rotating field generated by energizing the stator windings, the liquid metal contained in the bell is rotatively driven and centrifugally projected onto a circular diffusing device provided with hollow vanes, said liquid metal being thus directly driven into the conduits defined by said vanes. This method can be applied to the pumping of liquid sodium. (FR)

## Reactor Fuels

*Refer also to abstracts 19369, 20167, 20176–20179, 20181–20185, 20190, 20191, 20194, 20204, 20223, 20227, 20231, 20237, 20252, 20485, and 21477.*

**21843** (AECL-4912) TRANSIENT FISSION GAS RELEASE RATES WITHIN $UO_2$ FUEL ELEMENTS FOLLOWING POWER INCREASES. Campbell, F. R.; DesHaies, R.; Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Oct 1974. 40p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

A semi-empirical model has been developed to predict the rate of release of fission product gases following rapid changes in fuel

operating temperatures due to changes in power level. The model has been derived from the results of an in-reactor experiment in which the internal gas pressures of two stainless steel sheathed $UO_2$ fuel elements were monitored. The elements operated to burnups of about 100 MWh/kg U at average element linear powers of 55 kW/m. Their power level was then changed to about 70 kW/m for an additional 40 MWh/kg U. The model, which assumes that release kinetics can be approximated by diffusion equations, fits the observed time dependence of release very closely. 10 references. (auth)

**21844** NUCLEAR REACTOR FUEL ROD ASSEMBLY. Krett, V.; Stepanek, K. Czech Patent 150081. 20 Nov 1972. 6p. (In Czech).

A fuel rod is proposed consisting of a cluster of fuel elements with protective jackets equipped with helical fins for spacing the fuel elements. The height of the lead of the spacing fin helix decreases in the direction from the ends of the fuel elements towards their center. As a result of the decreased lead of the fin helix in the region of the maximum heat generation an increased turbulence of coolant as well as an increased heat transfer coefficient are achieved while not exceeding the maximum permissible surface temperature during the heat generation increase. (INIS)

## Reactor Control Systems

*Refer also to abstract 21769.*

**21845** (AECL-4580) CONTROL ANALYSIS OF ORGANIC-COOLED NUCLEAR POWER STATIONS. Part III. System Component and Controller Models and Overall Station Simulations. Wintonyk, B. L. M.; Barclay, F. W.; Lyon, R. B.; Frey, J. R.; Hawley, E. H. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Nov 1974. 155p. Dep. NTIS (US Sales Only) $10.75. AECL $3.50.

Models are developed for the key components and controllers. These, together with the reactor model are assembled and used to simulate the dynamic response of the system to various stimuli. Two particular control schemes were chosen to test whether the various models could be successfully assembled and the results of these tests are presented. The models are quite general and various control schemes can be studied by changing the modulated variables. 13 references. (auth)

**21846** (HEDL-TME-71-52) BORON CARBIDE MATERIAL IRRADIATION EXPERIMENT (MV-1) IN A CORE POSITION IN EBR-II. Engineering Test Plan. Basmajian, J. A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1971. Contract AT(45-1)-2170. 31p. AT.

Boron carbide has been selected as the reference control rod material for the FTR. The use of boron carbide minimizes the number of in-core control rods and results in the highest achievable flux and power for the reactor. Before the material form, composition, and operating parameters can be specified, performance data must be obtained under conditions approximating those expected for FTR. Neutronic calculations have shown the feasibility of such an experiment containing appreciable amounts of $^{10}B$, being performed in a Row 4 core position in EBR-II. The $^{10}B$ reaction characteristics of this position are such that the use of boron carbide enriched to 92% $^{10}B$ will adequately simulate the calculated FTR $^{10}B$ reaction conditions. On the basis of the need for data and the favorable neutronic calculations, the approval to conduct this experiment was obtained. (auth)

**21847** (ND-681120) CHANNEL ENGINEERING SYSTEM RESEARCH SUGGESTION FOR THE FFTF TO THE PACIFIC NORTHWEST LAB., A DIVISION OF BATTELLE MEMORIAL INSTITUTE. (Aerojet-General Corp., Sacramento, Calif. (USA)). Oct 1968. 39p. Dep. NTIS $5.00.

A research suggestion is described for the development of a computerized design and documentation system for interconnecting cabling systems for the FFTF, with the capability for future adaptation to the LMFBR program. Discussions were held with PNL personnel, including a presentation on the Channel Engineering System (CES) developed by Aerojet (part of the NERVA test operations effort for the NERVA engine test facility at the Nuclear Rocket Development Station). The presentation and subsequent discussion indicated that the NERVA system is directly related to, and consistent with, PNL's requirements. The NERVA CES, an advanced technique for the documentation and configuration control of a complex instrumentation and control system, is described. A technical discussion is also provided that indicates the requirements necessary for the accomplishment of the task and the associated program plan, including schedule and manpower estimates. (auth)

**21848** (NDS-8) CONCEPTUAL DESIGN STUDY REPORT: CONTROL AND DATA-HANDLING SYSTEM FOR THE FAST FLUX TEST FACILITY TO PACIFIC NORTHWEST LABORATORY, BATTELLE MEMORIAL INSTITUTE, RICHLAND, WASHINGTON. (Aerojet-General Corp., Sacramento, Calif. (USA)). Nov 1968. 385p. Dep. NTIS $22.25.

An integrated systems approach was utilized in the study and evaluation of the PNL FFTE Control and Data Handling System concept and requirements. The effort was initially divided into major areas for study. These areas were controls, data multiplexing and conversion, computer integration, simulation, and software. This resulted in specific recommendations and requirements and subsequent evolution into the recommended system concept. Considerable effort was devoted to analysis of the controls systems in the integrated reactor/plant operation to better define the C & DH system requirements. The recommended system concept resulted through the evolutionary process of the evaluation of the PNL concept and the incorporation of features required to meet the stated and evolved requirements. (auth)

**21849** (NP-20271) COMPUTER CONTROL SYSTEM SYNTHESIS FOR NUCLEAR POWER PLANTS THROUGH SIMPLIFICATION AND PARTITIONING OF THE COMPLEX SYSTEM MODEL INTO A SET OF SIMPLE SUB-SYSTEMS. Progress Report, October 1972–October 1973. Zobor, E. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). May 1974. 71p. Dep. NTIS (US Sales Only) $6.50.

The mathematical formalism for control systems simplification and partitioning is reviewed together with the theory of hierarchical control systems. The concept of the WWR-SM reactor control system is studied, and the derivation and partitioning of the reactor model is discussed. Model parameters are identified, and various strategies are compared. (DG)

**21850** (WANL-TME-1339) NRX/EST CONTROL SYSTEM OPERATION AND DESCRIPTION. Walsh, J. M.; Hohmann, G. L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). Dec 1965. 32p. Dep. NTIS $4.75.

The NRX/EST Control System is described with diagrams. The EST control system consists of pressure, flux, and temperature control loops with temperature measured to pressure demand (T-P) slaving. These control loops are supplemented by the flux and temperature limiters, and a pressure error to temperature demand cross loop limiter. The ESR control system includes a turbine power control valve (TPCV) schedular or auto start circuit in addition to the reactor automatic startup control. The TPCV schedular circuit is used to open the TPCV on a preset profile to a desired pressure level in much the same way as the reactor auto start circuit moves the control drums and establishes a predetermined power level. Operation of the EST controls is described for normal and alternate bootstraps, no flux control, on-off temperature control, endurance run, and system mapping and dynamic tests. (auth)

**21851** APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNIQUES TO DIGITAL COMPUTER CONTROL OF NUCLEAR REACTORS. Macdonald, J. L.; Koen, B. V. (Univ. of Texas, Austin). Nucl. Sci. Eng.; 56: No. 2, 142-151(Feb 1975).

The application of two artificial intelligence techniques, heuristic programming and learning theory, to the problem of digital computer control of nuclear reactors is described. The purpose of using an artificial intelligence approach is to alleviate the requirement for a detailed mathematical model of the nuclear reactor system. A control system is developed which demonstrates the primary features of such an approach. Results are shown for several reactor and control problem variations using a computer simulated reactor. (auth)

**21852** MULTIPLEX ROD DRIVE CONTROL SYSTEM FOR BOILING WATER REACTOR. Reigel, D. W.; Goodale, E. E.; Moore, S. E. (General Electric Co., San Jose, Calif. (USA)). Neue Tech.; 16: No. 7, 259-264(Jul 1974).

The operation of General Electric's solid state multiplexed Rod Drive Control System for Boiling Water Reactors is described. Emphasis is put on the techniques used to overcome potential noise problems and to locate and identify system faults. The basic functions of the system and of the system it replaces are discussed. Also included is a brief description of the Rod Pattern Control System with Ganged Rod feature, and a rearranged multiplexed Rod Position Information System, both of which will be included on the Kaiseraugst Project. (auth)

**21853** INCORE INSTRUMENTATION FOR 1,300 MW PRESSURIZED WATER REACTORS. Aleite, W.; Dio, W. H.; Haebler, D. V. (Kraftwerk Union A. G., Erlangen (F. R. Germany). Reaktortechnik). Kerntechnik; 16: No. 10, 429-436(Oct 1974). (In English, German).

The core of a standard 1,300 MW PWR is equipped with 36 stationary detectors and 28 aeroball probes, all accommodated in a total of 6 instrumentation lances. The signals of the stationary detectors are processed and are used, to some extent in combination with signals from the out-of-core instrumentation system, to monitor the power density distribution in the core, to control in closed loop the axial power shape, and to limit axial power output density maxima. The last two functions were newly introduced into the control concept of 1,300 MW reactors. The aeroball system has been improved in comparison with earlier plants but still has the same function, namely, exact mapping of core variables. (auth)

## Nuclear Power Plant Economics

*Refer also to abstract 21882.*

**21854** (AED-CONF-74-406-004) NUCLEAR ENERGY AND SECONDARY ENERGY CARRIERS. Schulten, R.; Kugeler, K.; Barnert, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorentwicklung). 1974. 11p. (In German). (CONF-740976-2). INIS.

From 38th meeting of the German Physics Society; Nuernberg, F. R. Germany (23 Sep 1974).

A brief survey is given of the energy market in the FRG where the energy costs are primarily dealt with. Furthermore, an explanation of the following concepts for nuclear energy supply is given: high temperature reactors to generate current, nuclear coal gasification, nuclear remote energy and nuclear water fission. Finally, a review is given of the present state of development of high temperature reactors in the FRG. (GE)

**21855** (INIS-mf-1502) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: CHILE. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 117p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21856** (INIS-mf-1503) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: ARGENTINA. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 123p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21857** (INIS-mf-1504) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: EGYPT, ARAB REPUBLIC. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. vp. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21858** (INIS-mf-1505) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: GREECE. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 85p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21859** (INIS-mf-1507) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: PHILIPPINES. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 143p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21860** (INIS-mf-1508) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: MEXICO. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 143p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21861** (INIS-mf-1509) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: KOREA, REPUBLIC OF. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 119p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21862** (INIS-mf-2556) MARKET SURVEY FOR NUCLEAR POWER IN DEVELOPING COUNTRIES: TURKEY. Appendixes A–N. (International Atomic Energy Agency, Vienna (Austria)). Sep 1973. 113p. INIS.

Data gathered during the visit of the team of experts and other data gathered for general accuracy are presented. The method of approach, the data used in the analyses, the analyses made and the results of the studies are discussed. General data and methodology common to the studies for all countries are given. (auth)

**21863** (NP-20241) REPORT ON THE CHOICE OF THERMAL REACTOR SYSTEMS. (Department of Energy, London (UK). Nuclear Power Advisory Board). 1974. 28p. Dep. NTIS (US Sales Only) $4.50.

The UK's nuclear background and electricity demand up to 1990 to 1991 are discussed. The proposals of the members of the Board are considered in terms of safety and licensing with the technical, commercial and industrial factors affecting choice. Finally, the rates of build-up of nuclear programs possible with the main thermal reactor systems (gas cooled, PWR, SGHWR) are analyzed. The implications for ordering of fossil stations are discussed. (UK)

**21864** (WASH-1174-74) NUCLEAR INDUSTRY, 1974. (USAEC, Washington, D. C.). 1974. 115p. Dep. NTIS $8.75.

Information is presented on the U. S. nuclear industry under the headings of (1) nuclear power growth and economics, (2) reactors and components, (3) nuclear fuel cycle, (4) radioisotopes and radiation applications, (5) general energy and technology development, (6) safety and the environment, (7) nuclear regulation activities, and (8) AEC/industry and state activities. (DG)

**21865** THE ROLE OF NUCLEAR ENERGY IN MEETING ENERGY REQUIREMENTS. Bobleter, O. (Innsbruck Univ. (Austria)); Niesner, R. (Atominstitut der Oesterreichischen Hochschulen, Vienna). Elektrotech. Maschinenbau; 91: No. 6, 308-312(Jun 1974). (In German).

By reference to different considerations such as trends of growth, location of raw materials, growth estimates by the most important energy suppliers, future energy requirements etc. it is shown that, both from an international and an Austrian point of view, only the systematic development of nuclear energy will ensure the satisfactory solution of future problems. A comparison of the effects on the environment of coal, oil and atomic power stations presents a thoroughly favorable picture for nuclear power stations. A risk evaluation shows that nuclear power stations are among the safest installations. (INIS)

**21866** OPTIMIZATION OF OPERATING PARAMETERS OF NUCLEAR POWER PLANTS. Svec, P. V. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). Acta Polytech. (Prague), IV; No. 3, 83-90(1973). (In Czech).

From scientific conference of the Czech Technical University; Prague, Czechoslovakia (12 Jun 1973).

The methods are presented of optimizing the operating parameters of a nuclear power plant, consisting in the determination of the optimum thermal economy, the permissible operation regimes and the optimum total economy of operation. (INIS)

## Reactor Fuel Cycle Economics

*Refer also to abstract 19324.*

## Reactor Licensing and Regulation

**21867** (74-CNA-100, pp 4) ANNUAL REPORT - CNA NUCLEAR INSURANCE COMMITTEE. Tyrell, J. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

French version available in report 74-ANC-100.

In Canadian Nuclear Association 14th annual international

conference, Montreal, Canada, June 9-12, 1974. Vol. 1. President's address, CNA committee reports.

The Canadian Nuclear Liability Act, passed in 1970, has not yet been proclaimed. Certain modifications to it have been proposed, however, and are listed. (INIS)

**21868** (74-CNA-600, pp 14) RECENT DEVELOPMENTS IN NUCLEAR PLANT LICENSING IN CANADA. Jennekens, J. H. F. 1974.

From Canadian Nuclear Association 14th annual international conference; Montreal, Quebec, Canada (9 Jun 1974).

In Canadian Nuclear Association 14th annual international conference, Montreal, Canada, June 9-12, 1974. Vol. 6. Nuclear energy and the public.

Developments in Canadian licensing regulations over the past 5 years are summarized, with references. The Atomic Energy Control Board (AECB) considers it to be important that the public should be well informed of plans and proposals for new nuclear plants. The AECB is writing a set of licensing guides. The AECB has broadened its scope to include heavy-water plants, and has published guidelines on toxic hazards from hydrogen sulphide and its combustion product, sulphur dioxide. A new approach to reactor shutdown systems gives credit for a second shutdown system only if each system is fully effective and independent of the other. The AECB aims to keep exposure to radiation as far below the legal IRCP limits as possible, and that there shall be no needless exposure to radiation. Lessons learned from practice drills are written into emergency procedures. (INIS)

**21869** (DOCKET-50376-56) NORTH COAST NUCLEAR PLANT, UNIT 1. License Application, PSAR, Volume 1. (Puerto Rico Water Resources Authority, San Juan). 27 Jan 1975. 529p. Dep. NTIS $29.50.

The former Aguirre Nuclear Plant is to be relocated at a site on the north central coast of Puerto Rico, within the municipality of Arecibo. The site is known as Islote and is 2 miles east of Punta Las Tunus. Barceloneta is about 5.5 miles ESE of the site. Arecibo is approximately 6.5 miles to the west, and the city of San Juan is about 35 miles to the east. The reactor, which will be known as the North Coast-1 Reactor will employ a two loop PWR with a core designed for 1780 MW(t) corresponding to an electrical power output of 583 MW(e). (FS)

**21870** (FIND-50338-S1) FIND: NORTH ANNA POWER STATION, UNITS 1 AND 2. Horn, F. H. (ed.). (USERDA Technical Information Center, Oak Ridge, Tenn.). Feb 1975. 15p. Dep. NTIS $4.00.

An index is presented for the docket report material submitted in conjunction with the application for a nuclear power plant construction permit and operating license. The index citations are to the beginnings of major headings, sections, responses, etc., and refer to grid coordinates on microfiche sheets prepared for each docket report. (DCC)

**21871** (NEDO-20566) GENERAL ELECTRIC COMPANY ANALYTICAL MODEL FOR LOSS OF COOLANT ANALYSIS IN ACCORDANCE WITH 10CFR50 APPENDIX K. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). 1974. vp.

**21872** (RAI-75-1) REGULATORY ADJUDICATION ISSUANCES AND ISSUANCES OF THE BOARD OF CONTRACT APPEALS, January 1-18, 1975. (USERDA Technical Information Center, Oak Ridge, Tenn.). Feb 1975. 73p. TIC $4.00.

Issuances received from the U. S. Atomic Energy Commission, the Atomic Safety and Licensing Appeal Boards, and the Atomic Safety and Licensing Boards are presented. (DCC)

**21873** (RDT-E-15-2NC-T) CLASS 2 NUCLEAR COMPONENTS (SUPPLEMENT TO ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, SUBSECTIONS NA AND NC). (USAEC Division of Reactor Research and Development, Washington, D. C.). Dec 1974. 31p. RSO.

This standard supplements the rules for the construction of nuclear components that are covered by Subsections NA and NC of the 1974 Edition of the ASME Boiler and Pressure Vessel Code (the Code), Section III. (auth)

**21874** (RDT-F-7-3T(11-74)) MARKING OF COMPONENTS AND PARTS. (USAEC Division of Reactor Research and Development, Washington, D. C.). Nov 1974. 8p. RSO.

This standard covers surface marking of components and parts purchased in accordance with RDT standards. The standard covers permanent identification marking and temporary marking for interim identification, layout, instructional, or control purposes during manufacture or installation that are placed directly on the surface of the item. This standard does not cover the marking of mill material purchased to RDT standards. (auth)

**21875** (WASH-1327-S1) USE OF RECYCLE PLUTONIUM IN MIXED URANIUM-PLUTONIUM OXIDE FUELS IN LIGHT-WATER NUCLEAR POWER REACTORS. (USAEC Regulatory Staff, Washington, D. C.). 20 Dec 1974. 18p. Dep. NTIS $4.00.

Draft proposed amendments to 10CFR, Parts 50 and 51, which pertain to the use of recycle plutonium in LWR mixed oxide fuels, are presented and explained. A copy of the AEC plans for a public hearing on Generic Environmental Statement Mixed Oxide Fuel (GESMO), which appeared in the Federal Register, is also included. (DG)

**21876** POSSIBLE MODIFICATION OR EXTENSION OF THE PRICE-ANDERSON INSURANCE AND INDEMNITY ACT OF 1957 IN ORDER FOR PROPER PLANNING OF NUCLEAR POWER-PLANTS TO CONTINUE WITHOUT DELAY HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-THIRD CONGRESS, SECOND SESSION: JANUARY 31, MARCH 27, AND 28, 1974. Washington, DC; Joint Committee on Atomic Energy (1974). 408p. GPO $3.55.

**21877** NUCLEAR REACTOR SAFETY. Part 1. Hearings Before the Joint Committee on Atomic Energy Congress of the United States, Ninety-Third Congress, First Session on the Status of Nuclear Reactor Safety, January 23, September 25, 26, 27, and October 1, 1973. Washington, DC; Joint Committee on Atomic Energy (1974). 668p. GPO $5.40.

**21878** THE REVISION OF THE FRENCH ATOMIC LAW. Bischof, W. (Goettingen Univ. (F.R. Germany). Abt. Atomenergierecht). Atomwirt., Atomtech.; 19: No. 10, 489-494(Oct 1974). (In German).

It was not before 1963 that in France, where the erection of reactors and other large nuclear power plants was reserved to governmental organizations, special legal regulations for the control of nuclear power plants were formulated, especially taking into account this fact. In 1973 there had been a revision of these regulations, which are forming the basis for the planned increase of nuclear energy in the electricity field, taking into account the corresponding questions of safety and environmental protection; furthermore, this revision should bring about improved licensing procedures. (auth)

**21879** SHALL LIABILITY INSURANCE ALSO COVER NUCLEAR DAMAGE TO MEANS OF TRANSPORT. Warrikoff, A. (Reaktor-Brennelemente G.m.b.H. (RBG), Grossauheim (F.R. Germany)). Atomwirt., Atomtech.; 19: No. 10, 488-489(Oct 1974). (In German).

The usefulness is discussed of the new provision proposed in the Government bill for the amendment of the Atomic Energy Law, according to which the liability insurance of the owners of nuclear plants shall also cover damage to means of transport. The advantages of the new provision, as given in the Government statement for the justification of the proposal, will not compensate the costly interference in the systematics of the insurance household. (GE)

# GENERAL AND MISCELLANEOUS

## Civilian Defense

**21880** (AD-783952) POSTATTACK CONTINGENCY PLANS FOR UNDAMAGED AREAS. Final Report, April 1973–March 1974. Goen, R. L.; White, W. L. (Stanford Research Inst., Menlo Park, Calif. (USA); Defense Civil Preparedness Agency, Washington, D. C. (USA)). Jul 1974. Contract DAHC20-73-C-0187. 50p. (SRI-EGU-2594). NTIS $3.25.

The development of contingency plans for undamaged areas in the postattack period after a nuclear attack is the subject of this report. An associated working paper presents a prototype checklist of actions to be performed in response to events under various contingencies. This report presents the rationale and criteria for the contingency plans and gives a synopsis of the plans. (auth)

## Energy Utilization and Economics

**21881** (DHEW/FDA-75-8010, pp 24-30) CHALLENGE OF INTEGRATING ENVIRONMENTAL AND ENERGY GOALS. Rowe, W. D. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The challenge of integrating environmental, energy, and economic goals in the United States and worldwide are discussed. It is pointed out that the Earth's energy budget is composed of inputs from solar radiation, tidal energy, and the energy from nuclear, thermal, and gravitational sources, with more than 99% of this input solar radiation, of which less than 0.05% is converted by photosynthesis to energy storage in plants. During the past 100 years economic growth has depended on energy inputs from fossil fuels. During 1970 the total energy used in the United States was the equivalent of 2.7 billion tons of coal, with 95.9% provided by fossil fuels, 3.8% provided by falling water, and 0.3% by the fission of $^{235}U$. By the year 2000 it is predicted that the annual US demand for energy in all forms will double this amount. The need for long-range planning to meet this demand is stressed. (CH)

**21882** FRONTIERS OF POWER TECHNOLOGY. Proceedings of a Conference Held at Stillwater, Oklahoma, October 11–12, 1972. Stillwater, OK; University of Oklahoma (1972). vp. (CONF-7210125-).

The sixteen papers presented deal with economic and environmental considerations of energy resource development and utilization. A separate abstract was prepared for one paper dealing with LMFBR type reactors. (DG)

*For an abstract of an individual paper see: 21440.*

**21883** HEALTH EFFECTS OF ALTERNATIVE MEANS OF ELECTRICAL GENERATION. Hub, K. A.; Schlenker, R. A. (Argonne National Lab., IL). pp 463-482 of Population Dose Evaluation and Standards for Man and his Environment. Vienna; International Atomic Energy Agency (1974).

From seminar on radiological safety evaluation of population doses and application of radiological safety standards to man and the environment; Portoroz, Yugoslavia (20 May 1974). See STI/PUB-375; CONF-740529-.

The objective of the paper is to provide a discussion and quantitative display of health effects resulting from electrical energy generation. Three broad categories of health effects are considered: disease mortality, gene mutation and genetic death, and accidental injury and death. These effects for a nominal 1980 period were defined for the nuclear, coal, and oil energy systems that included all activities from mining of fuel through disposal of waste from the generating plants. The health impacts were expressed in terms of man-days lost for an annual production of $6.6 \times 10^9$ kW · h of electrical energy from the system. For the items quantified the oil-fired system had the fewest number of man-days lost and the coal-fired system the highest value. The predominant contribution to health and accident impacts for nuclear systems comes from the effects on employees and their progeny and not from the effects on the public at large. (auth)

## Law

*Refer also to abstracts 21290 and 21878.*

**21884** (DHEW/FDA-75-8003) REGULATIONS FOR THE ADMINISTRATION AND ENFORCEMENT OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968. (Bureau of Radiological Health, Rockville, Md. (USA)). Jul 1974. 42p.

The Radiation Control for Health and Safety Act was signed by the President on October 18, 1968. The purpose of this Act was to protect the public from unnecessary exposure to radiation from electronic products. Radiation covered in the Act was called electronic product radiation and was defined to mean any ionizing electromagnetic or particulate radiation or any sonic, infrasonic, or ultrasonic wave which is emitted from an electronic product as the result of the operation of an electronic circuit in such product. The provisions of the Act give the Secretary, Department of Health, Education, and Welfare, authority to establish and carry out an electronic product radiation control program which shall include performance standards for electronic products. The regulations contained herein have been promulgated under that authority. The Bureau of Radiological Health is responsible for the day-to-day operation in carrying out the Act's mandate for an electronic product radiation control program. A principal objective of the program is to protect the public health through setting and enforcing electronic product radiation emission performance standards. This compilation is revised periodically, and efforts are made to provide an accurate reproduction of the regulations up to the date of this publication. This publication contains those regulations published in the Federal Register through April 20, 1974. (auth)

**21885** (DHEW/FDA-75-8010, pp 140-144) NUCLEAR POWER PLANT SITING LEGISLATION. Blanc, G. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The status of legislation in the USA during May 1974 relevant to the licensing and siting of nuclear power plants is reviewed. (CH)

**21886** (DHEW/FDA-75-8010, pp 150-161) 10 CFR PART 50 PROPOSED APPENDIX I: AS LOW AS PRACTICABLE. Rogers, L. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

On December 3, 1970, the Atomic Energy Commission published in the Federal Register (35 F. R. 18385) amendments to 10 CFR Part 50 that specified design and operating requirements for nuclear power reactors to keep levels of radioactivity in effluents as low as practicable. The amendments provided qualitative guidance, but not numerical criteria, for determining when design objectives and operations meet the requirements for keeping levels of radioactivity in effluents as low as practicable. The Commission noted in the Statement of Considerations to the amendments the desirability of developing more definitive guidance in connection with the amendment and that it was initiating discussions with the nuclear power industry and other competent groups to achieve this goal. On June 9, 1971, the Atomic Energy Commission published in the Federal Register (36 F. R. 11113) for public comment proposed amendments to 10 CFR Part 50 which would supplement the regulation with a new Appendix I to that part to provide numerical guides for design objectives and technical specification requirements for limiting conditions for operation for light-water-cooled nuclear power reactors to keep radioactivity in effluents as low as practicable. The principal changes recommended for the proposed amendments are discussed. (CH)

**21887** LEGAL ASPECTS OF RADIATION PROTECTION IN ITALY. Nocera, F.; Polvani, C. (CNEN, Rome). Radiol. Prot. Bull.; No. 9, 6-12(Oct 1974).

The Italian regulations governing activities involving possession, storage, production, utilization, handling, treatment and disposal of natural and artificial radioactive substances, together with the use of apparatus generating ionising radiations, are discussed. The administration of this legislation in Italy is described, together with the penalties for infringements of the regulations (criminal prosecution, with penalties for infringements of the regulations (criminal prosecution, with penalties of fines and/or imprisonment, as well as common law sanctions such as suspension or revocation of permits). The authors suggest that criminal prosecution should no longer be applicable to cases

where no serious hazards were created. A revision of the Italian legislation is now expected. (UK)

**21888** REQUEST FOR SUPPLEMENTAL FISCAL YEAR 1975 FUNDS FOR AEC NUCLEAR WEAPONS TESTING. Hearing Before the Joint Committee on Atomic Energy, Congress of the United States, Ninety-Third Congress, Second Session on Atomic Energy Commission Request for Supplemental Fiscal Year 1975 Funding for the Testing of Nuclear Weapons, September 23, 1974. Washington, DC; Joint Committee on Atomic Energy (1974). 35p. GPO.

A report is made by the committee of the Task Force for the Nuclear Test Ban concerning opinions on the AEC's request for supplemental funds for the nuclear weapons testing program. The AEC was seeking the additional $42 million in funds to cover the cost of the nuclear test program that was revised in light of the negotiations of the threshold Treaty Limiting Underground Nuclear Tests signed in Moscow on July 3, 1974. The Congress was urged to disapprove the funding. It was inconsistent with the objective of seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time as agreed to in the Limited Test Ban Treaty and reaffirmed in the Non-Proliferation Treaty and again in the threshold treaty. (MCW)

**21889** NUCLEAR WEAPONS AND FOREIGN POLICY. Hearings Before the Subcommittee on U.S. Security Agreements and Commitments Abroad and the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, United States Senate, Ninety-Third Congress, Second Session, March 7, 14, and April 4, 1974. Washington, DC; Committee on Foreign Relations (1974). 320p. GPO.

An effort is made to bring to public knowledge all information on the deployment abroad of U. S. nuclear weapons that would not aid a possible enemy. To date, the Congressional committees knew little about these deployments, their location and nature, the reasons for said deployments, the circumstances governing them, the agreements relating to their use, and the strategic doctrine incident to their deployment. A historical background and related alliances and pacts are discussed in many statements. (MCW)

**21890** ARMS CONTROL AND DISARMAMENT AGENCY. Hearings Before the Subcommittee on National Security Policy and Scientific Developments of the Committee on Foreign Affairs, House of Representatives, Ninety-Third Congress, Second Session, September 24, 25, October 1, 2, and 3, 1974. Washington, DC; Committee on Foreign Affairs (1974). 246p. GPO $2.25.

An examination of the Arms Control and Disarmament Agency was conducted to review its effectiveness. The Agency had not been reviewed during the 13 years of its existence. There were indications that Agency activities had veered away from original congressional intentions and there was growing concern that ACDA no longer played a role in the formulations and execution of U. S. arms control policies. The hearings were largely concerned with the Agency's past performance and present capabilities. The main emphasis was on the future and on the prospects and requirements for arms control and what role the Agency might play in that effort. (MCW)

**21891** X-RAY ORDINANCE; HERE: APPOINTMENT OF EXPERTS. Circular Letter of the MS of 9.1.1974 – II – 22.50.17 – GueltL 91/4. Niedersaechsisches Ministerialbl.; No. 4, 104 (1974). (In German).

The experts for the Land Lower Saxony in accordance with paragraph 4, par. 1 are appointed to be: the administrative office of the Land and the technical surveillance associations in Hamburg and Hannover. (GE)

**21892** EXECUTION OF THE ATOMIC ENERGY LAW; HERE: GOVERNMENTAL CONTROL OF OPERATION OF ACCELERATOR EQUIPMENT IN MEDICAL ESTABLISHMENT IN ACCORDANCE WITH PARAGRAPH 19 OF THE ATOMIC ENERGY LAW. Notification of 22.1.1974 by Circular Letter of the BMI Dated 22.3.1973 – UA II 1-6362-031. Gemeinsames Ministerialbl., A; No. 5, 80-85 (1974). (In German).

The full text of the provisions and of annexes 1 to 5, as well as of the instructions given to the responsible supreme Laender authorities regarding the application of these regulations according to paragraph 19 of the Atomic Energy Law is given. (GE)

**21893** RECENT DEVELOPMENT AND IMPLEMENTATION PROBLEMS IN ITALIAN RADIOPROTECTION LAWS. Nocera, F. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz.; 17: No. 1, 18-23 (1973). (In Italian).

Two basic decrees recently promulgated for implementation of certain provisions of Decree of the President of the Republic no. 185 of 13th February 1964, that is the Italian radioprotection law are considered: the two above decrees are DPR 5th December 1969, no. 1303 and Decree by the Ministry of Health 14th July 1970. They both appear to be of considerable importance, as they are intended to determine the scope of application of D.P.R. no. 185 and exemptions from such D.P.R. respectively. The main problems arising from the implementation of the above quoted decrees are pointed out, by means of interpretation also in connection with the international origin (Euratom Directions) of Italian radioprotection laws. (auth)

**21894** U.S. FOREIGN POLICY AND THE EXPORT OF NUCLEAR TECHNOLOGY TO THE MIDDLE EAST. Hearings Before the Subcommittees on International Organizations and Movements and on the Near East and South Asia of the Committee on Foreign Affairs, House of Representatives, Ninety-Third Congress, Second Session, June 25, July 9, 18, and September 16, 1974. Washington, DC; Committee on Foreign Affairs (1974). 342p. GPO.

The proposal of the United States to enter into agreements with Egypt and Israel for cooperation in nuclear technology during June 1974 instigated hearings that were conducted from June to September, 1974. Focus was on proposed agreements with Egypt and Israel; determination of additional safeguards in such agreements; examination of U. S. policies toward nuclear proliferation and international nuclear cooperation; and how Congress can play a more effective role in examining draft agreements for nuclear cooperation, influencing U. S. nuclear policy, and responding to the many international ramifications of continued global nuclear proliferation. Statements and memorandums submitted for the record include information on civil uses of atomic energy, nuclear fuels and related data, power generation in the Middle East, and nuclear power safety. (MCW)

## Management

*Refer also to abstracts 19969 and 20006.*

**21895** (AD-784304) CLEAN UP, REHABILITATION, RESETTLEMENT OF ENIWETOK ATOLL, MARSHALL ISLANDS. Volume I. Draft Environmental Impact Statement. (Holmes and Narver, Inc., Anaheim, Calif. (USA)). Sep 1974. Contract DNA001-73-C-0155. 312p. NTIS $18.75.

The statement addresses a proposed project to remove and dispose of debris, structures, and soils which pose physical or radiation hazards or which pose obstructions to human habitation or the productive use of the land. The department of defense has been assigned responsibility to plan the cleanup phase of the proposed project. The statement also addresses the problem of the economic and social measures required to resettle the Eniwetok people in the atoll after 25 to 30 years of absence. During the post World War II period, the atoll was used as a proving grounds for development testing of modern weapons and weapons systems, particularly nuclear weapons. This resulted in the relocation of the inhabitants from the atoll, the creation of hazards, both physical and radiological, and the consequent loss of much of the productive capacity of the atoll. (GRA)

**21896** (AD-784305) CLEAN UP, REHABILITATION, RESETTLEMENT OF ENIWETOK ATOLL, MARSHALL ISLANDS. Volume II. Draft Environmental Impact Statement. (Holmes and Narver, Inc., Anaheim, Calif. (USA)). Sep 1974. Contract DNA001-73-C-0155. 428p. NTIS $24.50.

The report includes Eniwetok aerial radiological survey; report by the AEC task groups on recommendations for cleanup and rehabilitation of Eniwetok Atoll; Eniwetok Atoll master plan for island rehabilitation and resettlement; and letter from trust territory of the Pacific islands, Marshall Islands district, district planning office, March 19, 1974.

**21897** (AD-784306) CLEAN UP, REHABILITATION, RESETTLEMENT OF ENIWETOK ATOLL, MARSHALL ISLANDS. Volume III. Draft Environmental Impact Statement. (Holmes and Narver, Inc., Annaheim, Calif. (USA)). Sep 1974. Contract DNA001-73-C-0155. 52p. NTIS $5.75.

The documentation is a summary of the Draft Environmental Impact Statement (DEIS) for a proposed project to clean up the Atoll of Eniwetok and resettle the Eniwetok people on the atoll. The summary has been prepared specifically for translation into the language of the Eniwetok people. (GRA)

**21898** (AEC-tr-7601) GENERAL ORGANIZATION AND RESOURCES OF THE CEA. Part II. 1974. Translated from pp. 67-85 of CEA: Annual Report 1973. 27p. Dep. NTIS $4.50.

The organizational plan shows the general organization of the CEA and reveals that the activities of the latter comprise nuclear, military, and basic and applied research sectors. The nuclear sector includes a certain number of specific Centers and Mining Divisions of the CEA. The military sector includes

a certain number of specialized Research and Development Centers. The third sector covers, in the broad sense, Basic and Applied Research with the exception of what is carried out in the first two sectors. It corresponds to the activity of operational units other than the Directorate of Productions and the Directorate of Military Applications as well as to the scientific and technical activities of the Nuclear Research Centers. (MCW)

**21899** (DHEW/FDA-75-8010, pp 73-77) REPORT OF THE TASK FORCE ON TRAINING COORDINATING COMMITTEES. Wilson, E. F. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

The funding of training programs for radiation protection personnel by Federal agencies and the States is discussed. The need for more trained personnel is emphasized. (CH)

**21900** (DHEW/FDA-75-8010, pp 241-251) STATUS REPORT ON FEDERAL EMERGENCY RESPONSE PLANNING EFFORT. Beck, C. K.; Weaver, C. L.; Sanders, M.; Siebentritt, C.; Anderson, E. C. Oct 1974.

From 6th annual national conference on radiation control; San Antonio, Texas, USA (28 Apr 1974).

In 6th annual national conference on radiation control: new challenges.

Cooperative programs of US Federal Agencies for giving assistance and advice to the States in the development of emergency plans for handling radiation accidents that may result in contamination of the environment and health hazards to the population are reviewed. Primary efforts were focused on plans in States in which nuclear facilities are now operating. The roles of the Environmental Protection Agency, the Federal Disaster Assistance Administration, the Defense Civil Preparedness Agency, and the Bureau of Radiological Health in rendering assistance to the States are discussed. (CH)

**21901** (PAEC(A)-7212) ANNUAL REPORT, FISCAL YEAR 1971–1972. (Philippine Atomic Energy Commission, Manila). 1973. 204p. INIS.

The report summarizes the activities of the Philippine Atomic Energy Commission for fiscal year 1971–1972. Highlights of activities are the following: (1) research and development; (2) reactor operations; (3) radioisotope production; (4) promotion of the industrial uses of radioisotopes; (5) training and education; (6) licensing; (7) international relations; and (8) scientific publications. (INIS)

**21902** (SAND-74-0079) SANDIA LABORATORIES TECHNICAL CAPABILITIES. Applied Mathematics. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1975. Contract AT(29-1)-789. 20p. Dep. NTIS $4.00.

The activities that provide the basis for the applied mathematics capabilities within Sandia Laboratories are characterized. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied to research and development programs. (auth)

**21903** (SAND-74-0080) SANDIA LABORATORIES TECHNICAL CAPABILITIES: COMPUTATION SYSTEMS. (Sandia Labs., Albuquerque, N. Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). Jan 1975. Contract AT(29-1)-789. 15p. Dep. NTIS $4.00.

The activities that provide the basis for the computation systems capabilities within Sandia Laboratories are characterized. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs. (auth)

**21904** (WASH-1358) NUCLEAR RELATED TECHNICIAN DEMAND AND SUPPLY, SOUTHERN INTERSTATE NUCLEAR BOARD REGION, 1973. (USAEC Division of Labor Relations, Washington, D. C.). Nov 1974. 114p. Dep. NTIS $5.45.

A tabulation and analysis of a survey of nuclear-related technician demand and supply conducted on January 1, 1973 for the region served by the Southern Interstate Nuclear Board (SINB) are presented. The first survey was conducted in 1971 by the SINB. These two surveys have served dual purposes: the provision of basic data on nuclear-related technician labor market trends in the Southern region and the development and testing of a procedure, methodology, and questionnaire format to be used in extending this survey to all regions of the nation. Almost 10,500 nuclear-related technicians were reported employed in the Southern region in 1973, and employment was projected to increase at approximately 10% per year through 1976. However, the growth rates vary widely among the various clusters of technician jobs. (MCW)

**21905** PLANNING OF LARGER POWER PLANT UNITS. Koch, H. (VEBA-Kraftwerke Ruhr A. G., Gelsenkirchen (F. R. Germany)). VGB Kraftwerkstechnik, 54: No. 9, 587-595(Sep 1974). (In German).

11 figs.; 1 tab.; 1 ref.

Increasing fuel prices, and in particular substantial increases in capital costs, require, after carefully weighing all relevant factors, the following measures in design to ensure energy supply at a favorable price: (1) construction of large power plant units; (2) reduction of construction period by simplification of licensing procedure; (3) minimization of exaggerated requirements in the area of environmental protection; and (4) restraining inflationary trends. (auth)

**21906** FORMAL APPROACH TO SYSTEMS ANALYSIS. Jansen, P. J. Karlsruhe, Ger.; Gesellschaft fuer Kernforschung mbH (Nov 1974). 151p. (In German). (KFK-2066).

Procedures of scientific advice to political decision-makers are analyzed. The decision process is described and structured in such a way, that technology assessment including qualitative aspects will be possible. The approach is in terms of general systems theory. (tr-auth)

## Mathematics and Computers

*Refer also to abstracts 20005, 20032, 20071–20073, 20109 and 21208.*

**21907** (AAEC/E-313) STATISTICAL DISTRIBUTION FUNCTIONS FOR PRODUCTS OF VARIABLES WITH A GAUSSIAN DISTRIBUTION WITH ZERO MEAN. Bertram, W. K.; Clancy, B. E.; Cook, J. L.; Rose, E. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1974. 29p. Dep. NTIS (US Sales Only) $4.50.

The statistical distribution of a product of variables that have a Gaussian distribution is investigated. These distributions are found to be given, in general, by special functions. Expansions for these functions for small values of the variable and their asymptotic behavior are derived. The functions are tabulated for products of up to seven variates. Some simple integrals related to the functions are given. (auth)

**21908** (AECL-4928) STABLE RATIONAL MINIMAX APPROXIMATIONS TO THE MODIFIED BESSEL FUNCTIONS $I_0(x)$ AND $I_1(x)$. Blair, J. M.; Edwards, C. A. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Oct 1974. 53p. Dep. NTIS (US Sales Only) $5.75. AECL $1.50.

The report presents nearly-best rational approximations for the functions $I_0(x)$ and $I_1(x)$, with relative errors ranging down to $10^{-23}$. The numerator and denominator polynomials are expressed in minimal Newton form to eliminate the cancellation associated with previously published approximations. (auth)

**21909** (KAPL-M-7346) SCAMP: SURFACE CONTOUR APACHE-MATUS PLOTS. Loeber, J. F. (Knolls Atomic Power Lab., Schenectady, N. Y. (USA)). Dec 1973. 26p. Dep. NTIS $4.50.

SCAMP obtains geometric data from the THREED file produced by PAULA and MESH3D; numerical data used to create contours are taken from either the TEMP file produced by APACHE (containing temperatures or stress and strain quantities) or the TAPE13 file produced by MATUS (containing displacements). (MCW)

**21910** (RL-74-132) IMPROVED METHOD FOR THE NUMERICAL SOLUTION OF THE MAGNETIC FIELD INTEGRAL EQUATION. Collie, C. J.; Trowbridge, C. W. (Science Research Council, Chilton (UK). Rutherford Lab.). Nov 1974. 14p. Dep. NTIS (US Sales Only) $4.00.

The equation is solved by replacing the iron by a mesh of triangles in which the magnetization is a linear function of the nodal values. Curvilinear triangles for fitting the boundary of the iron are treated. (auth)

**21911** (SAND-74-0380) COLODE: A COLLOCATION SUBROUTINE FOR ORDINARY DIFFERENTIAL EQUATIONS. Hulme, B. L.; Daniel, S. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. AT(29-1)-789. 32p. Dep. NTIS $4.75.

The subroutine COLODE, which is intended primarily to integrate stiff ordinary differential equations by collocation methods, is documented. A brief description of COLODE is followed by user instructions and an example. Three sections are sufficient for the use COLODE. A final section describes the implementation of COLODE for numerical techniques and software design. (auth)

**21912** (SAND-74-0381) USING STFODE/COLODE TO SOLVE STIFF ORDINARY DIFFERENTIAL EQUATIONS. Hulme, B. L.;

Daniel, S. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 15p. Dep. NTIS $4.00.

The use of the subroutine STFODE to solve stiff ordinary differential equations is explained. STFODE is a simple driver for the subroutine COLODE, which solves o.d.e.'s by certain collocation methods known to be particularly effective on stiff equations. A sample program and its output are included to illustrate the use of STFODE. (auth)

**21913** (SAND-74-8244) SOME FORTRAN IV SUBROUTINES FOR THE PDP-8. Jones, H. D. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 6p. Dep. NTIS $4.00.

Four general purpose Fortran IV subroutines are presented for use on a PDP-8 minicomputer operating under the OS-8 operating system. Two of these provide for character and bit handling facilities. Another subroutine is a device handler for the DR8E digital I/O unit, which is one of the pieces of equipment available on the LAB8/E system. Finally, a subroutine is presented that simplifies the input of data to a program in a format-free manner. (auth)

**21914** (SGAE-2199) LIPREP: A PROGRAM FOR FORMATTED PRINT OUT OF NUMBERS AND TEXT AT PDP8/E. Jeager, Ch. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Nov 1973. 28p. (In German). (MA-11-73). INIS.

The format conversion routine LIPREP allows printing of variables that are stored internally in single integer, double integer floating point, or ASCII mode in any given print pattern or printing of preset textlines. For that purpose a halfword format string is used that consists of control characters and eventually additional information (the address of the variables and print format data, etc.) and packed ASCII characters for the textlines. This string is to be supplied by the user. (tr-auth)

**21915** (UCID-16650) UT LISP REFERENCE MANUAL. LLL Edition (Preliminary). Greenawalt, E. M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Aug 1973. Contract W-7405-Eng-48. 86p. Dep. NTIS $7.50.

LLL now possesses a working implementation of UT LISP for the 7600 computers. UT LISP was originated and developed on CDC 6000 series equipment at the University of Texas at Austin and is now considered the standard LISP implementation on 6000 equipment all over the world. The information content is complete and accurate for use at LLL only. Some chapters missing primarily cover material that is highly system-dependent and relevant only to the 6000 version. UT LISP was developed under a SCOPE-like operating system, and as much of its original code as possible has been retained in the 7600 implementation. Therefore, LISP is structured to run normally in batch mode, although excellent interactive capability was incorporated. LISP uses CDC display code internally and converts to 6-bit ASCII on input and output. A code translation table was included as an appendix to the manual. (auth)

**21916** (WANL-TME-756) GENERALIZED LEAST SQUARES PROGRAM. Saalbach, C. P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Astronuclear Lab.). 27 Apr 1964. 31p. Dep. NTIS $4.75.

Least squares computer programs are provided for (1) fitting polynomial functions to a set of data and (2) fitting polynomial functions with non-integral exponents to a set of data. (LTN)

**21917** (ZFK-271, pp 199-201) NATURE OF THE INTERFACE IN CAMAC SYSTEMS. Hirsch, W. (Technische Univ., Dresden). Feb 1974. (In Russian).

From 3rd international seminar on interactions of fast neutrons with nuclei; Gaussig, German Democratic Republic (5 Nov 1973).

In proceedings of the third international seminar on interactions of fast neutrons with nuclei.

Block diagrams of the registers of the KRS-4200 computer, the vertical master system of the CAMAC, and time path of the signals are given and discussed. (JSR)

**21918** ATOMKI PROGRAM LIBRARY AND ITS USAGE. Szekely, G.; Vertse, T. (ATOMKI, Debrecen, Hungary). ATOMKI (At. Kut. Intez.) Kozlem.; 16: No. 4, 361-372(1974). (In Hungarian).

The ATOMKI program library is briefly described and an outline is given of the procedure. The steps in the use of the control library are given. The formulation and corrections of the COSY program library are outlined. (JSR)

**21919** LIST OF COMPUTER PROGRAMS CONCERNING NUCLEAR PHYSICS. Vertse, T. (ATOMKI, Debrecen, Hungary). ATOMKI (AT. Kut. Intez.) Kozlem.; 16: No. 4, 389-451(1974). (In Hungarian).

A list is presented of the Hungarian nuclear physics computer programs, the language they are written in, and the task of the program. (JSR)

# Miscellaneous

**21920** (GSF-A-40) SCIENTIFIC PUBLICATIONS AND REPORTS 1971. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F. R. Germany)). Jun 1972. 27p. (In German). INIS.

A summary is given of all publications and internal reports which appeared in the year 1971 of the co-workers of the GSF in the fields of biology, microbiology, radiation botany, biochemistry, hematology, medical data processing, ecologic chemistry, radiation protection, radiohydrometry and coherent optics as well as of the deep storage (storage of radioactive materials in mines and seas). (GE)

**21921** (ORNL-UR-120) STATE POPULATION PROJECTIONS: A COMPARATIVE REVIEW OF NATIONAL SERIES AND THEIR PRACTICAL USEFULNESS. Bjornstad, D. J.; Patrick, C. H.; Nelson, K. P. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 38p. Dep. NTIS $5.00.

The nationally produced baseline population forecasts for local areas by the Bureau of the Census, the National Planning Association, and the Bureau of Economic Activity and Economic Research Service are evaluated. The preparation of population projections is reviewed by outlining the various components needed to to predict population under a stated set of assumptions and discussing how the components are treated by these three series. Next, the 1980 state populations projected by the three are examined by component and compared with one another and with 1973 state population estimates. Three major findings are that the population levels predicted by the three are often inconsistent, the primary cause of the inconsistencies is differences in the projected volume of net migration, and in many instances, the estimated 1973 state populations exceed the levels that the series project for 1980. None of the three series currently provides adequate baseline statistics. (MCW)

**21922** (UCRL-76471) EULERIAN–LAGRANGIAN METHOD FOR CONVECTIVE-DISPERSIVE TRANSPORT. Morrison, F. A. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. 6p. (CONF-741001-49). Dep. NTIS $4.00.

From CUBE symposium; Livermore, California, USA (23 Oct 1974).

Convective-dispersive transport in a one-dimensional compressible flow is solved using an Eulerian-Lagrangian technique. The transport of a tagged species, resulting from dispersion and gas flow in porous media, is studied. The velocity distribution of the bulk gas motion is calculated using an Eulerian viewpoint. This velocity distribution determines the motion of the Lagrangian mesh. The mixed Eulerian-Lagrangian approach is adopted as a means of avoiding anomalous numerical dispersion. A Lagrangian mesh moves along characteristic curves of the convective transport equation. Any transport relative to this mesh is dispersive. In the absence of physical dispersion, there is no transfer of the species between Lagrangian mesh points and concentration changes then result solely from compression and expansion of the fluid element. Because the flow is compressible, the Lagrangian mesh points are unequally spaced. Implicit methods for solution of the diffusion equation are developed for unequally spaced mesh points. Detailed calculations have been done for the transient, low Reynolds number, isothermal flow of an ideal gas. (auth)

## Chemistry

**21923** (COO-2026-16) SINGLET TO TRIPLET INTERSYSTEM CROSSING IN EXCITED KETENE. Zabransky, V. P.; Carr, R. W. Jr. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). 1974. 5p. (CONF-740607-2). Dep. NTIS $4.00.

From 11th informal conference on photochemistry; Nashville, Tennessee, USA (16 Jun 1974).

Measurements were made of relative $CH_2(^1A_1)$ and $CH_2(^3B_1)$ yields from $CH_2CO$ over a pressure range from 1.0 to 700 torr at 313 nm by a pair-wise photolysis technique. The objectives were to determine whether $CH_2CO$ might provide an example of the resonant limit and to see what inferences could be made about the triplet state of $CH_2CO$ from knowledge of the intersystem crossing kinetics. The experimental procedure and results are discussed. (MCW)

**21924** (KFKI-74-82) THERMAL PROPERTIES OF DISUBSTITUTED LIQUID CRYSTALLINE PHENYL BENZOATES. Szabon, J.; Bata, L.; Pinter, K. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Nov 1974. 16p. Dep. NTIS (US Sales Only) $4.00.

Thermal characteristics of some p-,p'-disubstituted phenyl benzoates are described. It was found that certain liquid crystal-

line compounds exhibit solid state polymorphism depending on their thermal history. A number of these also show rhythmic crystal growth. Influence of nucleation rate was also studied. (auth)

**21925** (LBL-3133) ELECTRONIC STRUCTURE IN SMALL INORGANIC MOLECULES: SOME RESULTS OBTAINED FROM X-RAY PHOTOELECTRON SPECTROSCOPY. Perry, W. B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1974. Contract W-7405-eng-48. 229p. Dep. NTIS $14.50.

Thesis.

X-ray photoelectron spectroscopy is used to study aspects of electronic structure in a number of primarily small, volatile inorganic compounds. Core and valence electron binding energies and Auger electron energies have been measured, and these data are interpreted using simple theoretical models. (LK)

## Life Sciences

**21926** (BNWL-B-379) COMPUTER-AIDED METHOD FOR ANALYSIS OF SNOP-CODED HISTOPATHOLOGY OBSERVATIONS. Olson, R. J.; Watson, C. R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1974. Contract AT(45-1)-1830. 76p. Dep. NTIS $5.45.

A series of FORTRAN computer (SNOP) programs, running on a CDC-CYBER computer, aid investigators in analysis of histopathology observations of research animals. Clinical and pathologic observations are coded, utilizing the Systematized Nomenclature of Pathology (College of American Pathologists, Chicago, IL, 1965). The first programs sort, uncode, and print them while checking for several types of errors. After the investigator edits these preliminary reports, the second programs print several tables of lesion incidence by treatment group, including a series summarizing neoplastic lesions. Included in this document are instructions for use of the programs, flowcharts, and a microfiche containing detailed FORTRAN code listings. (auth)

**21927** (CEA-R-4623) ANALYSIS OF THE SPONTANEOUS ACTIVITY OF THE DORSAL HIPPOCAMPUS PYRAMIDAL CELLS OF THE ADULT RABBIT. Bassant, M. H.; Court, L. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Jan 1975. 84p. (In French). Dep. NTIS (US Sales Only) $7.25.

The spontaneous unitary activity of pyramidal cells of the dorsal hippocampus was measured in curarized adult rabbits by means of microelectrodes. A complete statistical analysis of the data recorded during wakefulness and sleep was made by computer. (CH)

**21928** (CEA-R-4651) INTRODUCTION TO THE STUDY OF REFERENCE VALUES (STATISTICAL ASPECTS). Fagnani, F.; Pages, J. P.; Roy, E. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Jan 1975. 73p. (In French). Dep. NTIS (US Sales Only) $6.75.

Vast sets of data (biological, medical, biophysical) are collected on individuals, in preventive or curative medicine, for research purposes. The definition and computation of these data, generally multivariate and repeated along time, lead to various statistical problems. This "reference value theory" is applied in the field of medical and biological research for the interpretation of such data for diagnosis, screening, surveillance, or epidemiology. Different sorts of statistical statements are developed as far as numerous, multivariative data are concerned. (tr-auth)

**21929** (ORNL-tr-2782) INFLUENCE OF INCREASED TEMPERATURE ON PHOTOSYNTHESIS OF PHYTOPLANKTON. Devyatkin, V. G. Translated by H. S. Warren from Biol. Vnutr. Vod, Inform. Byull.; No. 18, 17-20(1973). 4p. Dep. NTIS $4.00.

Results are reported from laboratory studies on the effects of water temperature on the rate of photosynthesis in phytoplankton and blue-green algae maintained in an illuminated aquarium. (CH)

**21930** (RLO-2225-5-21) PAIN IN THE TORUS: SOME DIFFICULTIES WITH MODELS OF ISOLATION BY DISTANCE. Felsenstein, J. (Washington Univ., Seattle (USA). Dept. of Genetics). [nd]. Contract AT(45-1)-2225. 21p. Dep. NTIS $4.25.

Malecot's and Wright's models of isolation by distance seem to assume random distribution in space, Poisson distribution of offspring number, and independent migration of individuals. These assumptions are inconsistent. By calculating the probability of joint occupancy of two locations at a distance x, it is shown that a haploid model embodying the latter two assumptions violates the first, forming larger and larger clumps of individuals separated by greater and greater distances. Thus the model is biologically irrelevant, even though it is possible to use it to calculate probabilities of genetic identity at different distances. The formation of these clumps is verified by computer simulation. The same phenomenon occurs in two- and three-dimensional models. In models of finite regions (a circle or a torus) the formation of clumps takes the form of the certainty of ultimate local extinction of the organism in each region. This does not occur if we hold the number of individuals on the circle or torus constant, but considerable departure from random distribution still results. The stepping-stone models appear for the present to be the only well-defined models of geographically-structured populations with finite population density. (auth)

**21931** (RLO-2225-5-22) GENETIC DRIFT IN CLINES WHICH ARE MAINTAINED BY MIGRATION AND NATURAL SELECTION. Felsenstein, J. (Washington Univ., Seattle (USA). Dept. of Genetics). 1974. 34p. Dep. NTIS $4.75.

Genetic drift will cause a migration-selection cline to wobble about its expected position. A rough linear approximation is developed, valid when local populations are large. This is used to calculate effects of genetic drift on clines in a stepping stone model with abrupt and with gradual changes of selection coefficients at a single haploid locus. Among the quantities calculated are measures of slope, standardized variation of gene frequencies around their expected values, and correlation among neighboring populations with respect to deviations from the expected gene frequencies. These quantities appear to be primarily functions of Ns and Nm for a given pattern of selection. Computer simulation gives rough confirmation of these results. Standardized variances of gene frequencies and correlation of neighbors are spatially heterogeneous in the case of smooth changes in selection. In no case is pathological behavior of gene frequency deviations found near the boundaries of selective regions. Local behavior of gene frequencies of nearby colonies is approximately predicted by a simple adaptation of the stepping-stone theory of Kimura and Weiss. Approximate measures of the lateral variation of the midpoint of a cline and the probability of non-monotonicity are also calculated and discussed. (auth)

**21932** (RLO-2225-5-24) THEORETICAL STUDIES OF GENE SUBSTITUTION, GEOGRAPHIC VARIATION, AND SPECIATION. Comprehensive Report of Overall Activities. Felsenstein, J. (Washington Univ., Seattle (USA). Dept. of Genetics). 31 Jul 1974. Contract AT(45-1)-2225. 16p. Dep. NTIS $4.00.

**21933** (RLO-2225-T19-29) PROGRESS REPORT ON ACID-GROWTH THEORY OF PLANT CELL ELONGATION, JULY 1, 1973-JULY 1, 1974. Cleland, R. (Washington Univ., Seattle (USA). Dept. of Botany). 1974. Contract AT(45-1)-2225. 10p. Dep. NTIS $4.00.

**21934** (RLO-2226-T1-13) STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND THE FACTORS INFLUENCING THEM. Progress Report. Period Covered: August 1, 1972-July 31, 1974. (Oregon Univ., Portland (USA). Dept. of Biochemistry). [nd]. Contract AT(45-1)-581. 121p. Dep. NTIS $9.25.

**21935** (RLO-2226-T2-7) SOLUTE DRAG AND MEMBRANE TRANSPORT. Comprehensive Progress Report, 1971-1974. Van Bruggen, J. T. (Oregon Univ., Portland (USA). Medical School). 11 Jul 1974. 14p. Dep. NTIS $4.00.

**21936** (RT/BIO-(74)7) APPLICATION OF SEQUENTIAL ESTIMATION METHODS TO COUNTS OF PHYTOPLANKTON. Moeller, F.; Zattera, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Feb 1974. 76p. Dep. NTIS (US Sales Only) $7.00.

The methods of sequential estimation applicable to the counting of algae are described. (CH)

**21937** (TID-26717) GENERA CLATHROMORPHUM AND MESOPHYLLUM (CORALLINACEAE) FROM THE NORTHEAST NORTH PACIFIC OCEAN. Lebednik, P. A. (Washington Univ., Seattle (USA). Dept. of Oceanography). 1974. 331p. Dep. NTIS $19.75.

Thesis.

The developmental anatomy and surface morphology of species in the red algal genera Clathromorphum and Mesophyllum from the northeast North Pacific Ocean were studied. Over 150 collections were made spanning a period of nearly seven years ranging from Shemya Island in the Aleutian Islands to La Jolla, California. Specimens were taken at depths ranging from the intertidal to 100 m. (auth)

**21938** (UR-3490-630) CONSIDERATIONS IN ANIMAL EXPERIMENTATION TO ASSESS BIOLOGIC EFFECTS AND POTENTIAL HAZARDS OF EXPOSURE TO LASERS. Michaelson, S. M. (Rochester Univ., N. Y. (USA). Atomic Energy Project). 1974. 10p. (CONF-741069-2). Dep. NTIS $4.00.

From working group on health effects from lasers, Dublin, Ireland (20 Oct 1974).

Permissible exposure levels to laser energy have been extrapolated from animal data and are based on minimum physical

ophthalmoscopic and histologic changes. Uncertainties exist in extrapolation of animal data to humans. Choice of the experimental animal species is of prime importance. (CH)

## Materials

**21939** (AED-CONF-74-328-002) DISLOCATION INDUCED BOUND ELECTRON STATES IN TELLURIUM. Alpen, U. V.; Heyszenau, H. (Max-Planck-Institut fuer Festkoerperforschung, Stuttgart (F. R. Germany)). 1974. 17p. INIS.

From international conference on lattice defects in semiconductors; Freiburg im Breisgau, F. R. Germany (22 Jul 1974). With abstract.

The electronic structure of Te depends strongly on the defect content of the samples. Te-samples with a defined dislocation pattern were prepared and magnetooptical absorption measurements were carried out to study the nature of states bound to these dislocations. The intensity of the absorption peaks occurring close to the electronic gap of Te depends linearly on the density of dislocations. The anisotropy with respect to the relative direction of the magnetic field, the Burgers vector, and the dislocation line was investigated for a well-defined density of $\bar{a}$-edge dislocations. The energy of the lowest dislocation-induced peaks depends nonlinearly on the magnetic field. A theoretical model is set up describing the energy shift of the bound states as a function of the magnetic field for the orientation $\bar{B}$ parallel and perpendicular to the dislocation line. (auth)

**21940** (CEA-R-4585) PHOSPHORUS INTRODUCTION MECHANISM IN ELECTRODEPOSITED COBALT FILMS. Kravtchenko, J. F. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. d'Electronique et de Technologie de l'Informatique). Oct 1974. 82p. (In French). Dep. NTIS (US Sales Only) $7.25.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble, France.

The cathodic reduction of hypophosphite, phosphite, and phosphate ions was studied using chronopotentiometry and voltammetry. Then cobalt was deposited at constant current from a bath containing one of these three compounds. The current, while giving an electrodeposition of cobalt, also enhances at the same time a chemical deposition of cobalt. It is shown that high coercive forces in cobalt films are much more related to this chemical deposition than to the simple fact that the films contain some phosphorus. (tr-auth)

**21941** (CEA-R-4602) SINTERING STUDIES OF EX-CARBONYL NICKEL. Senevat, J. T. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Div. de Chimie). Jan 1975. 116p. (In French). Dep. NTIS (US Sales Only) $9.00.

Thesis. Submitted to Paris Univ., Orsay, France.

The structural evolution of sintered ex-carbonyl nickel was followed from the initial compressed-powder stage to the low porosity-sintered metal one. Prior to the effective sintering the importance of the solid-gas reactions between hydrogen and surface impurities of the powder was shown in regards to bridging phenomenon. The study of diffusion mechanisms during the first sintering stage displayed the major importance of superficial diffusion up to 600°C. A resistometric method was developed for this study. The study of the second and third sintering stages was made using stereological methods. Kinetics of grain growth were investigated. Microfractography and the thin foil studies of sintered structures gave interesting results. (tr-auth)

**21942** (CEA-R-4617) CONTRIBUTION TO THE STUDY OF POINT DEFECTS IN STAINLESS STEELS. Azarian, A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Etudes des Combustibles a Base de Plutonium). Nov 1974. 84p. (In French). Dep. NTIS (US Sales Only) $7.25.

Thesis. Submitted to Paris Univ., France.

Vacancies were studied in a stainless steel Cr 18-Ni 14 of very low impurity content, except for phosphorus, which was added in small and controlled quantities. Vacancies were studied by the positron annihilation technique; the formation energy was found equal to 1.6 ± 0.2 eV in the phosphorus-free steel and 1.2 ± 0.2 eV in the 0.05% phosphorus steel. Vacancy clusters formed after quenching were also studied by electron microscopy. The $\frac{1}{3}\langle 111\rangle$ Frank loop was observed in all our steels. In phosphorus steels $\frac{1}{2}\langle 110\rangle$ perfect loops and stacking fault tetrahedra were observed after respectively slow and fast quenches. (tr-auth)

**21943** (CEA-R-4642) TO REDUCE GRAIN GROWTH OF $LaCrO_3$ HEATING ELEMENTS IN 1700 to 1850°C TEMPERATURE RANGE, THE INFLUENCE OF SOME ADDITIONS HAVE BEEN STUDIED BY HEAT TREATMENT IN AIR. Saint-Jacques, R. G. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Transfert et Conversion d'Energie). Jan 1975. 23p. (In French). Dep. NTIS (US Sales Only) $4.25.

Most of the additions were introduced in aqueous solution form to realize a uniform coating on each particle, and have a homogeneous repartition after calcination, grain growth is reduced by cobalt addition but increased by molybdenum or magnesium addition. Experiments at 1850°C were made in a new type of furnace using $LaCrO_3$ heating element. Microstructure of $LaCrO_3$ heating elements after life tests were studied. (tr-auth)

**21944** (COO-913-52) FLUORESCENCE OF SIMPLE OLEFINS. Hirayama, F.; Lipsky, S. (Minnesota Univ., Minneapolis (USA). Dept. of Chemistry). 1973. Contract AT(11-1)-913. 15p. Dep. NTIS $4.00.

Weak fluorescence was observed from propylene, cis-2-butene, trans-2-butene, 1-hexene, cis-2-hexene, trans-2-hexene, 2-methyl-2-pentene, and 2,3-dimethyl-2-butene in vapor and solution phases. Emission spectra and quantum yields are presented. The transitions are tentatively assigned as originating from the lowest singlet Rydberg state. (auth)

**21945** (COO-1591-26) IMPURITY AND GRAIN SIZE EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIA AND ALUMINA. Lessing, P. A.; Gordon, R. S. (Utah Univ., Salt Lake City (USA). Div. of Materials Science and Engineering). Jul 1974. Contract AT(11-1)-1591. 26p. (CONF-740724-5; UTEC-MSE-74-110). Dep. NTIS $4.50.

From symposium on plastic deformation of ceramics; University Park, Pennsylvania, USA (17 Jul 1974).

Steady state, constant load, and creep experiments were conducted on pure and doped polycrystalline magnesium and aluminum oxides to determine: the effect of solid solution impurities (e.g. Fe, Cr, Ti) on deformation mechanisms, particularly as they relate to the concentration of lattice defects; the effects of impurities, atmosphere, and grain size on the relative contribution to viscous deformation of lattice and grain boundary diffusion of both cationic and anionic species; and the relative roles of viscous and non-viscous deformation mechanisms. (auth)

**21946** (COO-1591-27) IMPURITY EFFECTS ON THE CREEP OF POLYCRYSTALLINE MAGNESIUM AND ALUMINUM OXIDES AT ELEVATED TEMPERATURES. Technical Progress Report, December 19, 1973-December 18, 1974. Gordon, R. S. Dec 1974. Contract AT(11-1)-1591. 40p. (UTEC-MSE-75-1002). Dep. NTIS $5.00.

Research is described on the non-viscous creep of large grain size MgO, doped with iron; viscous creep of fine-grained, high purity MgO; the effect of grain size on creep of polycrystalline $Al_2O_3$, doped with iron; and stress relaxation tests on polycrystalline MgO and $Al_2O_3$, pure and doped with iron and chromium. Results show that the power law creep (N ~ 3) of iron-doped MgO is independent of the iron dopant level (creep rates nearly the same as undoped MgO), grain size and oxygen partial pressure. The creep activation energy is ~71 kcal/mole. Viscous creep was identified in fine grained (6-24$\mu$m) MgO by relating the transient creep behavior to simultaneous grain growth. Tentative results indicate that both magnesium lattice and grain boundary diffusion contribute to the overall creep rate. Iron doping appears to enhance magnesium lattice diffusion and suppress cation grain boundary diffusion. Increased iron dopant levels and/or decreasing oxygen partial pressures increase cation lattice diffusion in polycrystalline $Al_2O_3$ such that oxygen grain boundary diffusion becomes rate-limiting in diffusional creep. Estimates were made of both aluminum lattice and oxygen grain boundary diffusitives in iron-doped, polycrystalline $Al_2O_3$. Preliminary stress relaxation experiments on pure and doped polycrystalline $Al_2O_3$ and MgO were performed. Stresses up to 1000 Kg/cm$^2$ and strain rates up to 1h$^{-1}$ were achieved without fracture. Well defined power law creep regimes (stress exponents between ~3 and 9) were identified in the high stress regime. (auth)

**21947** (COO-2166-21) STUDY OF GRAIN BOUNDARY SEGREGATION USING THE AUGER ELECTRON EMISSION TECHNIQUE. Annual Technical Progress Report-IV, January 1-December 31, 1974. Stein, D. F.; Heldt, L. A. (Michigan Technological Univ., Houghton (USA). Dept. of Metallurgical Engineering). 1974. Contract AT(11-1)-2166. 21p. Dep. NTIS $4.25.

The segregation of impurities to grain boundaries was studied in nickel and nickel-based alloy systems. It was found that the major segregating species was sulfur and that it is primarily responsible for the deterioration of the mechanical properties. In nickel it was found that embrittlement did not occur until precipitation had occurred, but in Ni-Al and Ni-Al-Ti it appears that segregation without precipitation causes embrittlement. In Ni-Al and Ni-Al-Ti alloys, it was found that interaction of sulfur decreased with increasing temperature and this was explained on the basis of a distribution of energy sites associated with the grain

boundary. In the corrosion studies it was demonstrated through the combined use of Auger Electron Spectroscopy and Energy Dispersive X-Ray Analysis that stress corrosion cracking of copper base alloys was a consequence of the continuous formation of an oxide and its subsequent fracture. In ferritic stainless steels, it was demonstrated that chromium depletion within 10 atomic layers of the grain boundary area was responsible for the intergranular attack in boiling 65% nitric acid. (auth)

**21948** (IEA-336) METHODS IN GROWING MICROCRYSTALS OF CALCIUM SULFATE. Guenin, N. (Instituto de Energia Atomica, Sao Paulo (Brazil)). May 1974. 12p. Dep. NTIS (US Sales Only) $4.00.

Some of the chemical properties of calcium sulfate as well as isothermal and non-isothermals methods in growing crystals of $CaSO_4$ are discussed. Special emphasis is placed on the crystal growth in gel. (auth)

**21949** (IFVE-SPK-73-74) EVALUATION OF FILM QUALITY FOR AUTOMATIC MEASUREMENT. Kuchin, Yu. M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1973. 12p. (In Russian). INIS.

A criterion for film quality representing the minimum permissible difference between optical track density and background was obtained on the basis of noise analysis. The criterion can be used to evaluate requirements on film quality for specific automatic measurement installations. (INIS)

**21950** (IS-3518) MAGNETIC PROPERTIES OF MnPt AND CoPt. Chen, C. W.; Buttry, R. W. (Iowa State Univ. of Science and Technology, Ames (USA)). 1974. 8p. Dep. NTIS $4.00.

Magnetization measurements were conducted on ordered and disordered polycrystalline specimens of MnPt and three Co-Pt alloys between 4.2 and 293°K. The magnetic data, while confirming the onset of antiferromagnetism in the ordered MnPt, reveal the presence of ferromagnetic regions in the disordered MnPt. Chemical order tends to exert a pronounced (~30%) adverse effect on saturation magnetization ($M_{s,0}$) of the Co-Pt alloys at 0°K near the equiatomic composition. Meanwhile, the effect of Co concentration on $M_{s,0}$ of the Co-Pt alloys is shown to be appreciable only when the Co content exceeds 50%. (auth)

**21951** (JINR-E14-8293) DETERMINATION OF THE CRYSTAL FIELD PARAMETERS FOR $Pr^{3+}$ IN $LaF_3$ FROM LEAST-SQUARES FITS. Matthies, S.; Welsch, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 25p. Dep. NTIS (US Sales Only) $4.25.

The results of least-squares fits of the energy levels of $Pr^{3+}$ in crystalline $LaF_3$ are reported. Especially by carrying out a 23-variable fit involving the crystal field parameters as well as free-ion parameters second-order effects due to J-mixing are taken into account. From testing the resulting energies and eigenfunctions by inelastic neutron scattering experiments the reported crystal field parameters are expected to describe the physics of $Pr^{3+}$ in $LaF_3$ sufficiently well. (auth)

**21952** (JUL-1001-FF) STUDY OF LOCAL MAGNETIC PROPERTIES OF WEAKLY ORDERED $Ni_3Mn$ BY MEANS OF MAGNETIC SMALL-ANGLE NEUTRON SCATTERING. Denkhaus, U. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Festkoerperforschung; Bochum Univ. (F. R. Germany)). Sep 1973. 69p. (In German). INIS.

From the N-scattering measurements on weakly assigned $Ni_3Mn$, supplemented by magnetization measurements, two essential results were obtained: (1) an unusually high uniaxial anisotropy of small, strongly magnetic regions, and (2) a direction-correlated, inhomogeneous magnetization of the matrix in these regions, which disappears into a homogeneous matrix magnetization with increasing external field. (GE)

**21953** (LBL-2767) LIQUID PHASE DENSIFICATION TECHNIQUE FOR THE LEAD ZIRCONATE TITANATE SYSTEM. Sherohman, J. W. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1974. Contract W-7405-eng-48. 86p. Dep. NTIS $7.50.

Thesis.

By combining conventional processing methods that are known to enhance sintering, a unique liquid phase densification technique was investigated for the PZT system. The technique is a two-step process: (1) utilization of a low temperature liquid phase ($PbO \cdot PbF_2$) to optimize, with the aid of applied pressure, the rearrangement of the PZT particles on formation of the liquid, and (2) a subsequent heat treatment to allow liquid phase sintering to occur. During this heat treatment a fixed PbO atmosphere was established to remove the liquid from the PZT material in a controlled manner, thus producing a dense single phase PZT ceramic of fixed stoichiometry. The evaporation of $PbO \cdot PbF_2$ from $PZ_{0.5}T_{0.5}$ was experimentally observed using thermogravimetry. The evaporation rate was found to be dependent on the partial pressure of PbO as set by multi-phase packing powder compositions within the PZT system. The rate of liquid removal was further sensitive to both the density and temperature of the $PZ_{0.5}T_{0.5}$ specimen. As the density increases to a closed pore geometry, the rate of evaporation of the liquid phase became thickness dependent. The PbO vapor pressure of the $PZ_{0.5}T_{0.5}$ material containing the PbO rich liquid was determined for the evaporation rate in a PT + P packing powder using the Langmuir equation. By comparing the Langmuir PbO vapor pressure at different temperatures with the PbO vapor pressure from Knudsen effusion data, the evaporation coefficient was calculated as approximately $1.8 \times 10^{-6}$ in the temperature range of 1150 to 1250°C. In addition, ferroelectric and piezoelectric measurements were made on $PZ_{0.5}T_{0.5}$ specimens of various intrinsic nonstoichiometry that were initially densified by the liquid phase densification technique. (auth)

**21954** (LBL-3629) PHOTOTHERMAL IONIZATION SPECTROSCOPY. Haller, E. E.; Hansen, W. L.; Goulding, F. S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1974. Contract W-7405-eng-48. 24p. (CONF-741213-6). Dep. NTIS $4.25.

From nuclear science symposium; Washington, District of Columbia, USA (11 Dec 1974).

A photoconductivity study of shallow hydrogenic impurities in germanium revealed that sharp lines occurred at energies below the threshold of the particular impurity and that their energies corresponded precisely to the energies of the absorption lines produced by the excitation of carriers from the ground state of an impurity to bound excited states. Theoretical considerations showed that the photoconductivity peaks are produced by a two-step process involving first excitation from the ground state of an impurity (donor) to one of the excited states, then subsequent ionization by a phonon into the conduction band, or valence band if acceptors are dealt with. The free carriers created increase the conductivity of the sample. The superior sensitivity of PTIS is demonstrated on a high-purity germanium sample and provides analysis of all shallow impurities in high-purity germanium down to concentrations below $10^8$ $cm^{-3}$. The deepest acceptor observed in Ge is substitutional copper with a ground state energy of 43 MeV. PTIS has sufficient sensitivity for investigation of very pure, thin, or small samples such as epitaxially grown layers on semiconductors. (MCW)

**21955** (MHSMP-74-38) DEVELOPMENT DIVISION QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1974. Myers, L. C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1974. Contract DA-11-173-AMC-487(A). 14p. Dep. NTIS $4.00.

For Lawrence Livermore Lab., Livermore, CA.

The effects of three sample conditioning variables on the chemical reactivity test were investigated and it was determined that (1) a one degree change in the temperature of the oil bath will have a significant effect on the amount of gas evolved from PBX 9404, (2) the depth that the sample holders are emerged in the oil bath must be controlled, and (3) there was little or no difference in the amount of gas evolved from ground and unground PBX 9404. A rather unusual dependence of the decomposition rate of PETN upon particle size was observed. As the particle size is decreased the decomposition rate decreased. (auth)

**21956** (MHSMP-74-43) PARTICLE CHARACTERIZATION OF RDX-MDF, BULK RDX, AND HNS SUPPLIED BY SANDIA AFTER VARIOUS STORAGE CONDITIONS. Period Covered: July-September 1974. Duncan, A. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1974. Contract DA-11-173-AMC-487(A). 27p. Dep. NTIS $4.50.

For Sandia Labs., Albuquerque, NM.

Particle characterization was performed for RDX powder from bulk storage and from an MDF geometry and for HNS in bulk form. Bulk storage was completed on RDX and HNS up to 3 months while stored at 295, 320, and 345 K in unsealed, vacuum, and air-filled closed sample containers. Particle size did not change appreciably under these storage conditions. RDX filled MDF tubes were also stored at 295, 320, and 345 K for 3 months in both aluminum and lead tubes. Particle size changed for the RDX/MDF with the greater and most rapid change occurring in the aluminum tubes. (auth)

**21957** (SAND-74-0064) REPLACEMENT MATERIALS FOR ADIPRENE L-100/MOCA: A SURVEY REPORT. Arnold, C. Jr. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 50p. Dep. NTIS $5.50.

In response to the OSHA ruling on MOCA, a survey on the suitability of various classes of encapsulating materials as replacements for Adiprene/MOCA was made. Because of their mechanical toughness, polyurethanes are the preferred type of encapsulant for most of the applications where Adiprene/MOCA is used. Specific

non-MOCA and non-TDI containing commercial polyurethanes that show considerable promise as replacements for Adiprene/MOCA were identified. The toxicology of flexible encapsulants was reviewed. (auth)

**21958** (SAND-74-0257) STRESS WAVE MEASUREMENTS IN EARTH PENETRATOR EXPERIMENTS. Carlson, G. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 62p. Dep. NTIS $6.25.

Stress waves in the soil medium were measured during earth penetrator experiments using lithium niobate gauges. Experiments were conducted at the McCormick Ranch site near Albuquerque, New Mexico, and at the Watching Hill site near Suffield, Alberta, Canada. In the Watching Hill experiments, a 0.152 m dia, 127 kg penetrator traveling at a velocity of 156 m/s generated stress waves ranging from 0.6 MPa at a horizontal distance of 0.45 m to 0.025 MPa at 1.2 m. Agreement of the measured stress wave amplitude, wave shape, and arrival time with calculations based on a soil cap model is good. (auth)

**21959** (SAND-74-0344) SURFACE CLEANING IN THIN FILM TECHNOLOGY. Mattox, D. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 32p. Dep. NTIS $4.75.

A clean surface is one that contains no significant amounts of undesirable material. The types and origin of various contaminants are discussed. Since cleaning is often equated with adhesion, the mechanism of adhesion to oxide, metal, and organic surfaces is reviewed and cleaning processes for these surfaces are outlined. Techniques for monitoring surface cleaning are presented and the importance of storage of clean surfaces is detailed. (auth)

**21960** (SAND-74-8510) MEASUREMENT OF RESIDUAL STRESSES IN AN ALUMINUM CYLINDER PLATED WITH THICK NICKEL–COBALT ALLOY. Dini, J. W.; Benedetti, G. A.; Johnson, H. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 25p. Dep. NTIS $4.25.

A hole drilling technique and its related analysis were used to determine the principal residual stresses in an aluminum cylinder plated with thick nickel-cobalt alloy. The residual stresses obtained with this technique agreed quite well with those measured by the rigid strip method. (auth)

**21961** (UCRL-13615) INVESTIGATION ON THE LOW TEMPERATURE SPECIFIC HEAT OF FCC ALLOYS CHARGED WITH HYDROGEN. Final Report. Massalski, T. B. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Metal Physics Lab.). 1974. 53p. Dep. NTIS $5.75.

For Lawrence Livermore Lab., Livermore, CA.

The presently performed measurements of the electronic specific heat coefficient $\gamma$, within the narrow range of the $\alpha$-phase of Pd–H alloys, show that $\gamma$ decreases on alloying. The behavior on alloying of the electron-phonon enhancement factor and of the paramagnon interactions is not known. If it is assumed that these enhancement factors are the same as in pure Pd, the decrease of $\gamma$ in Pd–H alloys is very nearly like that predicted by a band calculation for pure Pd. If, as is more likely, the enhancement factors decrease on alloying the observed trend in the $\gamma$ coefficient may be interpreted as having a slope that is less steep than the slope dictated by the rigid band model. When the electronic specific heat is measured in hydrogen-bearing Pd alloys that have been subjected to deformation by compression the value of the $\gamma$ coefficient depends on the temperature. Following room temperature deformation and aging the $\gamma$ coefficient changes little from the value characteristic of the undeformed sample. On the other hand, the $\gamma$ coefficient increases substantially (towards the value of pure Pd) if deformation is done at liquid $N_2$ temperature and the sample is allowed to warm up and age at room temperature. The interpretation of this behavior is that the first operation, involving deformation at room temperature, leaves the nature of hydrogen unchanged from the atomic form (even though the actual distribution of hydrogen may have changed, as indicated by internal friction and autoradiography) while the second operation, involving deformation at liquid $N_2$ temperature and warming up, changes the nature of hydrogen from atomic to molecular. This information is expected to contribute to the general understanding of the role played by hydrogen in producing embrittlement effects. (auth)

**21962** (UCRL-51717) STOCHASTIC FINITE ELEMENT SIMULATION OF THE NONLINEAR STRUCTURAL RESPONSE OF FIBROUS COMPOSITE MATERIALS. Larder, R. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jan 1975. Contract W-7405-eng-48. 98p. Dep. NTIS $8.00.

Thesis.

The development of a statistical simulation applicable to unidirectional fiber composites is described and several examples re given. The finite element method is used to perform a number of nonlinear simulations in which the strength of individual fibers is varied randomly along its length in accordance with a simple model of faults. Initially, the lowest strength fiber in the model is identified and then a series of linear elastic problems are solved. Following each solution, segments of those fibers assumed to have failed are eliminated from the model. Failure is subsequently determined by both the strength variation and the stress concentration effects as various fiber failures occur throughout the model. As the fibers continue to fail in a random manner, the failure stress of the entire model can be estimated by observing the number of fiber failures per load increment. The number of failures per load increment increases relatively slowly at first until a cascading effect abruptly increases the number of failures causing failure of the entire model. Since the size of structures that can be simulated directly by this method is limited, an extension was also developed so that the failures of individual fibers need not be simulated. The application of a deterministic 3-dimensional finite element analysis to the micromechanics of non-parallel fiber structures is also demonstrated. (auth)

## *Physics and Engineering*

**21963** (BDX-613-1180) WIRE WOVEN TAPE MEASUREMENTS. Berry, C. W. Jr. (Bendix Corp., Kansas City, Mo. (USA)). Dec 1974. Contract AT(29-1)-613. 18p. Dep. NTIS $4.00.

A method for measuring the length, width, and thickness of nylon/copper-wire woven tapes was developed. Tapes are mounted on a constant tension and velocity reel system that allows continuous measurement of tapes. Length is measured with a rotary encoder and width and thickness are measured with flex-pivot strain gage devices. (auth)

**21964** (CEA-R-4645) APPARATUS FOR PULSING A XENON ARC LAMP. Gilles, L.; Lemoine, C.; Lesigne, B.; Nacass, P.; Sutter, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Div. de Chimie). Jan 1975. 17p. (In French). Dep. NTIS (US Sales Only) $4.00.

An apparatus for increasing the light emission from a xenon arc lamp for a short period (≈1 ms) is described. It was found that the increase in the light intensity decreases with wavelength in going from 250 to 800 nm. Used in conjunction with a monochromator and a photomultiplier this apparatus enables the absorption spectra of short lived species to be observed. (tr-auth)

**21965** (COO-3352-6) THERMAL NEUTRON SCATTERING STUDIES OF MOLECULAR DYNAMICS AND CRITICAL PHENOMENA IN FLUIDS. Annual Progress Report, December 1973–November 1974. Chen, S. H. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 1974. Contract AT(11-1)-3352. 13p. Dep. NTIS $4.00.

Progress is reported on coherent and incoherent neutron scattering in dense gases; development of a photon correlation spectrometer for the study of critical phenomena; and theoretical work in the kinetic theory of dense gases. Two significant measurements were made in dense gases. Coherent scattering from nitrogen gas at a range of pressures up to 512 atm was performed at BNL and incoherent scattering from hydrogen gas at pressures up to 2000 atm was done at ANL. A digital correlator in the form of a compact, integrated unit was developed for a computerized photon correlation spectrometer being completed. A digital computer program that is capable of calculating the dynamic structure factor of dense gases corresponding to conditions under which the neutron experiments were done was developed. (MCW)

**21966** (GSF-K-9) INTRODUCTION TO X-RAY PHYSICS. Goettel, K. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (F. R. Germany). Inst. fuer Strahlenschutz). Jun 1974. 40p. (In German). INIS.

After an introduction dealing with the structure and properties of atoms, this report discusses the physical foundations of X-radiation, its effect on matter, and the characterization and conditioning of the radiation quality. (GE)

**21967** (JAERI-M-5733) SIMULATION TECHNIQUES OF DISTRIBUTED PARAMETER SYSTEMS USING A HYBRID COMPUTER. Shimazaki, J.; Watanabe, K.; Hara, M. (Japan Atomic Energy Research Inst., Tokyo). Jun 1974. 56p. (In Japanese). Dep. NTIS (US Sales Only).

Basic methods used in hybrid computer simulations for dynamic analysis of a distributed parameter system are described. A nodal analysis and CSDT methods are treated, and simulation methods of a simple time lag system are investigated from the viewpoint of a kind of a distributed parameter system. Hybrid simulation techniques on time lag systems and both of single and counter flow heat exchangers are studied in detail, which are expressed in the form of hyperbolic partial differential equations,

and important methods to accelerate operation speed with reasonable accuracy are presented. General discussions on time lag systems and comparisons between CSDT and DSCT methods are given in the appendices. (auth)

**21968** (ORNL-TM-4813) SUMMARY REPORT: ELECTROCHEMICAL AMBIENT AIR MONITOR FOR CHLORINE/CHLORIDE. Mueller, T. R.; Fisher, D. J.; Goldberg, G.; Gouge, P. S.; Ross, H. H.; Strain, J. E.; Shults, W. D. (Oak Ridge National Lab., Tenn. (USA)). Feb 1975. Contract W-7405-eng-26. 32p. Dep. NTIS $4.75.

The purpose of this work was the development of a prototype ambient air monitor for chlorine and chlorides. The prognosis for a short development time was based on the assumption that prior electrochemical development could be coupled with a minimum of mechanical and electronic development to produce a workable monitor. It was necessary, however, to find a new electrochemical basis for the monitor when requirements for simultaneous determination of chlorine and chlorides were detailed. Electrochemical development, several delays in component procurement and electronic fabrication, and difficulties experienced in obtaining reliable absorption and electrolyte flow systems made it necessary to stop work before a working field model was constructed. An electrochemical base has been developed for the determination of chlorine and chlorides in the atmosphere in the range 0 to 1000 ppb. Applied in the manner described there are few anticipated interferences with the method. A very flexible and reliable programmer-data acquisition/processing package was developed. An efficient scrubber for the removal of traces of chlorine and HCl from the atmosphere was developed. The electrochemical flow cell design is described. A prototype performed reliably for long periods. Some work is still needed on the cell to convert the laboratory version into a field model. A generator for introducing chlorine into an air stream for calibration purposes is described. The overall concept was tested with prototype units and it was found that the system can work as expected. The lower limit of detection appears to be lower than predicted. It may not, however, be possible to apply the monitor directly to air containing more than 1 ppm. It is believed that a useful monitor, superior in performance to available or advertized ones, could be constructed at reasonable cost by a commercial instrument manufacturer. (auth)

**21969** (SAND-74-0321) THEORY OF AN ELECTROOPTIC ACCELEROMETER. Damerow, R. A.; Smith, G. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 15p. Dep. NTIS $4.00.

The nonrelativistic theory of a measurement technique which uses both optical interferometry and electronic delay differentiation to produce a measurement of the acceleration of a moving surface is described. In contrast to purely optical approaches, this technique is particularly suitable for acceleration measurements in the 10 to 100 kilo "g" range. The theory stresses the phase relations between the interfering signals, both optical and electronic, and clearly displays the approximations which are made to develop the final working equations. This approach provides a systematic means of analyzing such systems and provides insight into proper application of the Doppler equation. In particular, it is shown that phase analysis leads to exactly the relativistic Doppler equation evaluated at times retarded by the time required for light to propagate from the moving surface to the detector. An analysis of the inherent errors of such a system is performed, and it is shown that they may be readily estimated using only the measured average acceleration, its time derivative, and the net electronic delay time $\Delta t$. (auth)

**21970** (SAND-74-0392) SHOCK SPECTRA. Rodeman, R. (Sandia Labs., Albuquerque, N. Mex. (USA)). Oct 1974. Contract AT(29-1)-789. 28p. Dep. NTIS $4.50.

The uses and properties of the shock spectrum of an excitation are presented. Included among the important uses are the establishment of upper and lower bounds on the peak response of linearly modeled multi-degrees-of-freedom systems from the shock spectrum of the excitation, and the selection of test excitations to simulate complex field environments. Two of the properties of the shock spectrum that are developed are the relationship between the Fourier transform of the excitation and the shock spectrum, and an energy bound on the excitation directly from the shock spectrum. A discussion is given of two computer programs, that were written to compute shock spectra. A numerical example that shows the validity of the various bounds that are obtainable from the shock spectra is also presented. (auth)

**21971** (SAND-74-0403) ASYMMETRIC ROTATING MIRROR TURBINE DEVELOPMENT. Hughes, R. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 20p. Dep. NTIS $4.00.

Design considerations, material selection, development and test of an asymmetric high-speed air turbine driven mirror system are described. The conditions for dynamic balance of the mirror head and the effect of residual unbalance are presented. Performance to 8000 revolutions per second was achieved. The system developed offers substantial improvement in performance over the turbines presently in use at Sandia Laboratories in the rotating mirror framing cameras RMFC-201. (auth)

**21972** (SAND-74-0409) MONOPULSE-RADAR POINTING ERROR DUE TO MULTIPATH PROPAGATION OVER A ROUGH TERRAIN. Edrington, T. S.; Aronson, E. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1974. Contract AT(29-1)-789. 29p. Dep. NTIS $4.50.

Analyses of radar pointing error due to multipath effects usually employ specular terrain models. Since terrain is generally non-specular at radar frequencies, the specular results can be misleading. A rough-terrain model is used and the dependence of pointing error on several antenna, terrain, and geometric parameters (which do not occur in the specular case), is used. A few specular results are given for comparison. (auth)

**21973** (SAND-74-8257) STUDY OF IMPINGING AXISYMMETRIC TURBULENT FLOWS: THE WALL JET, THE RADIAL JET, AND OPPOSING FREE JETS. Witze, P. O. (Sandia Labs., Albuquerque, N. Mex. (USA)). Jan 1975. Contract AT(29-1)-789. 185p. Dep. NTIS $12.25.

Thesis.

The results of an experimental and analytic study of impinging axisymmetric turbulent flows are presented. Three impinging-flow configurations are considered: a single axisymmetric turbulent jet impinging normal to a plate; two directly-opposing axisymmetric turbulent jets of equal momentum flux impinging against each other; and a constrained radial jet as produced by the radial flow from an annular orifice formed by two parallel circular disks. The purpose of the investigation is to characterize the structure of these flows, with the goal of identifying and analytically modeling the regions of physically similar flow behavior. (auth)

**21974** (SAND-75-0030) SOME OBSERVATIONS ABOUT THE STEERAD RADAR LOCATION ESTIMATION AND GUIDANCE SYSTEM. Cooper, J. A. (Sandia Labs., Albuquerque, N. Mex.. (USA)). Jan 1975. Contract AT(29-1)-789. 13p. Dep. NTIS $4.00.

Knowledge on the STEERAD radar location estimation and guidance system is assessed. The assessment is based largely on recent analysis of experimental data, on theoretical treatments, and on computer modeling results. Answers to several fundamental questions were sought as specific goals of this project, and these questions are examined. (auth)

**21975** (UCID-16705) LLL IMAGE-CONVERTED SPECTROGRAPH: INSTRUCTION MANUAL. Harney, R. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1972. Contract W-7405-eng-48. 38p. Dep. NTIS $5.00.

The LLL image-converted spectrograph is basically a 1-meter, Littrow-type, grating spectrograph equipped with an image converter and camera system. The primary application of the image-converted spectrograph is in continuous monitoring of mode-locked laser bandwidths. The assembly, operation, and calibration of the spectrograph are described in detail. (WHK)

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